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FIG. 1

PRIOR ART

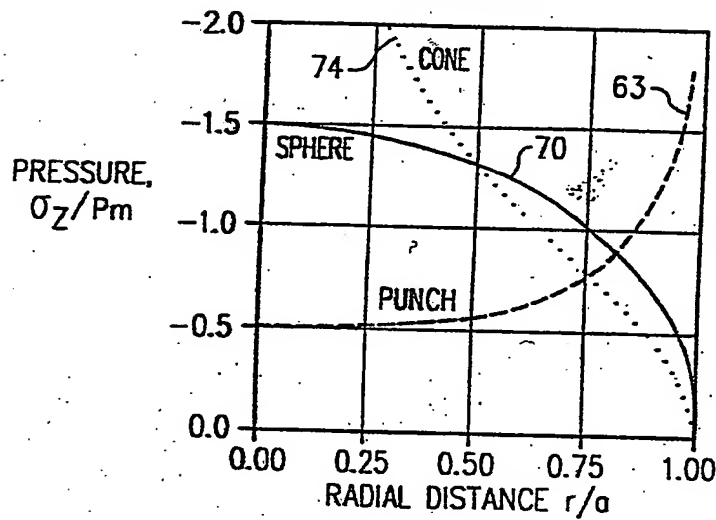


FIG. 2

PRIOR ART

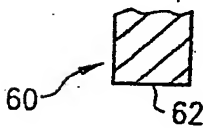


FIG. 3

PRIOR ART

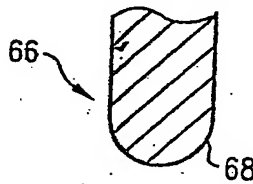


FIG. 4

PRIOR ART

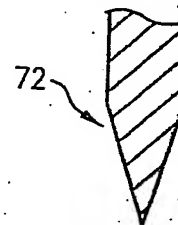
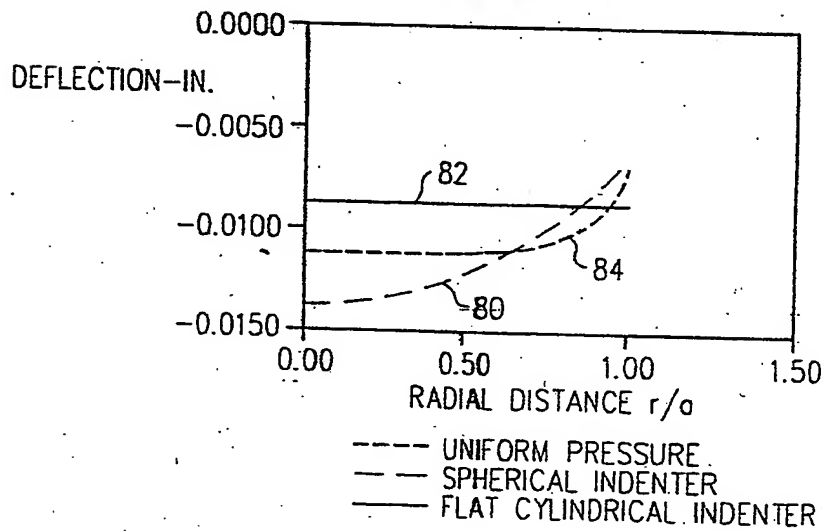


FIG. 5



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FIG. 6

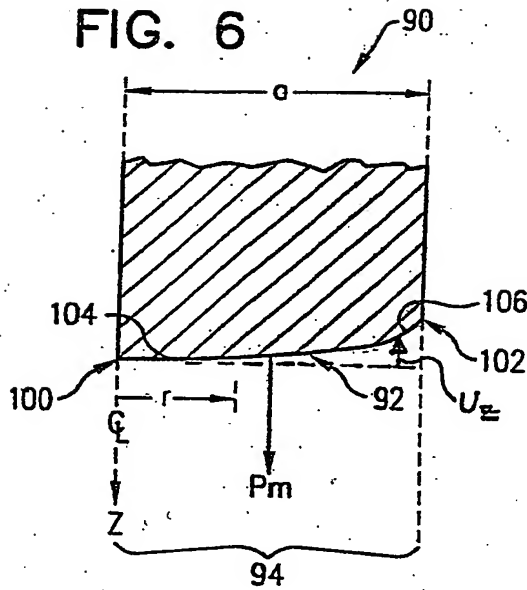


FIG. 7

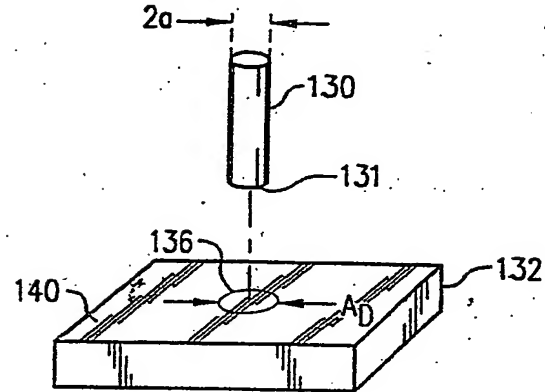


FIG. 8

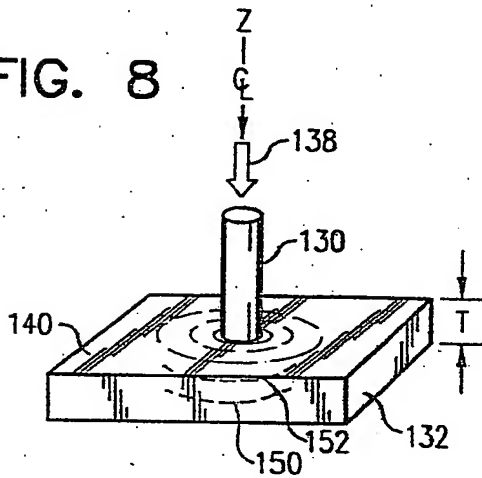


FIG. 9

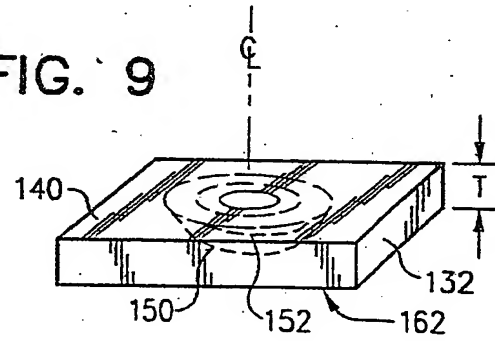
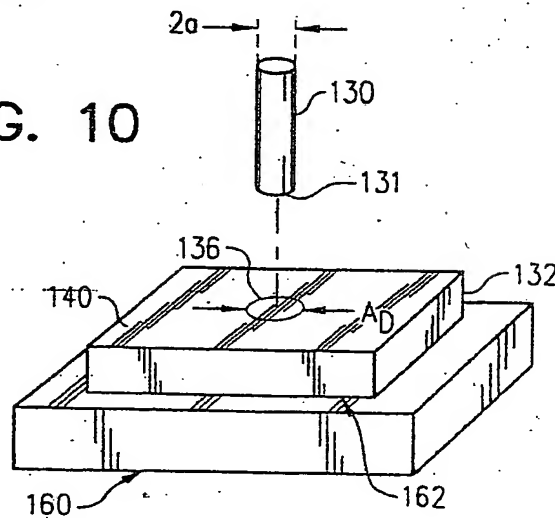


FIG. 10



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FIG. 11

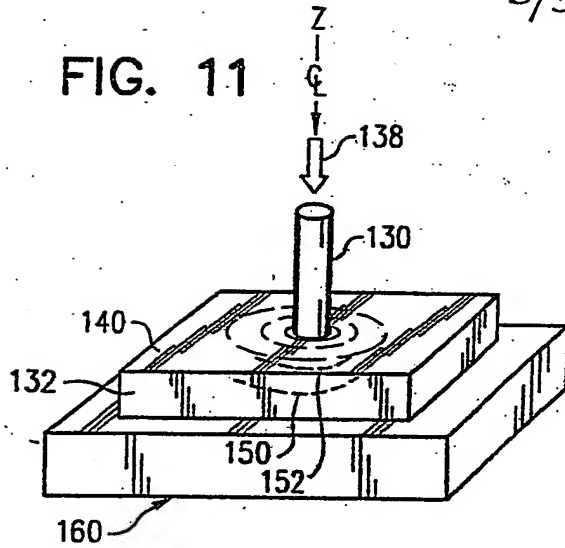


FIG. 12

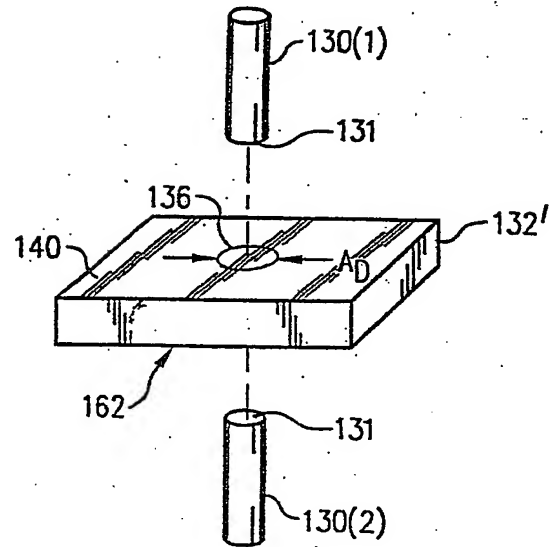


FIG. 13

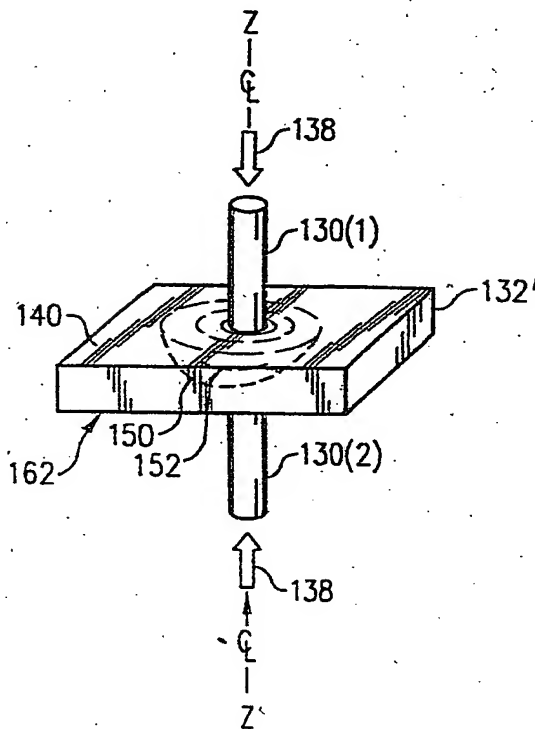
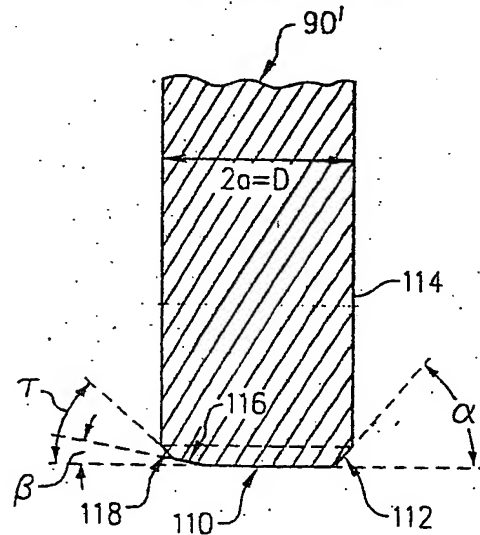


FIG. 14



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FIG. 15

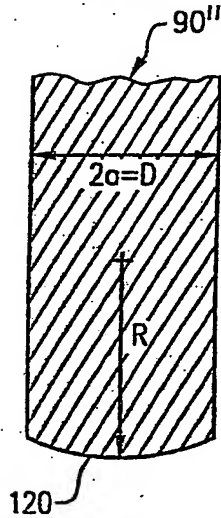


FIG. 16

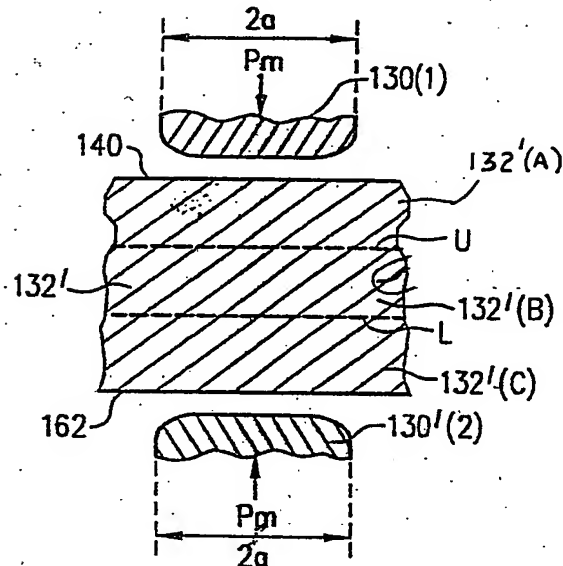


FIG. 17

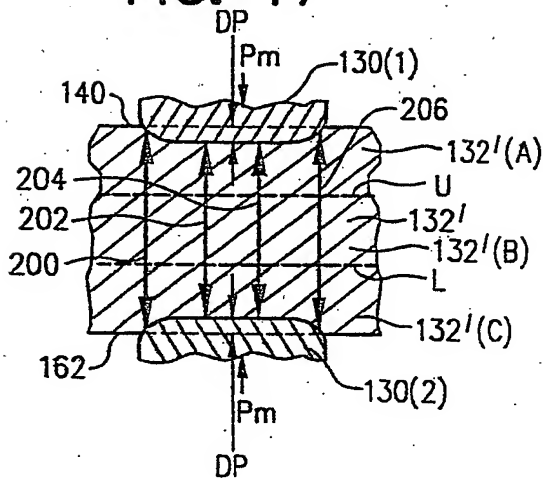


FIG. 18

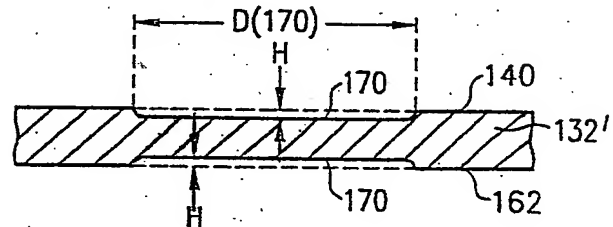


FIG. 19

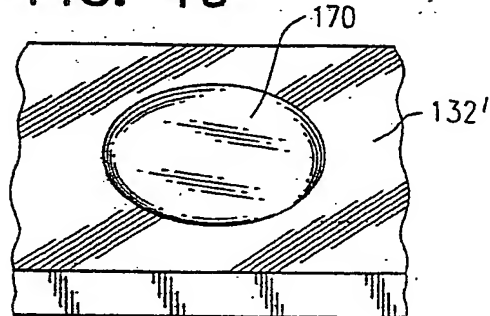
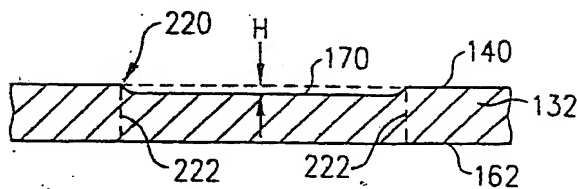


FIG. 20



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FIG. 21

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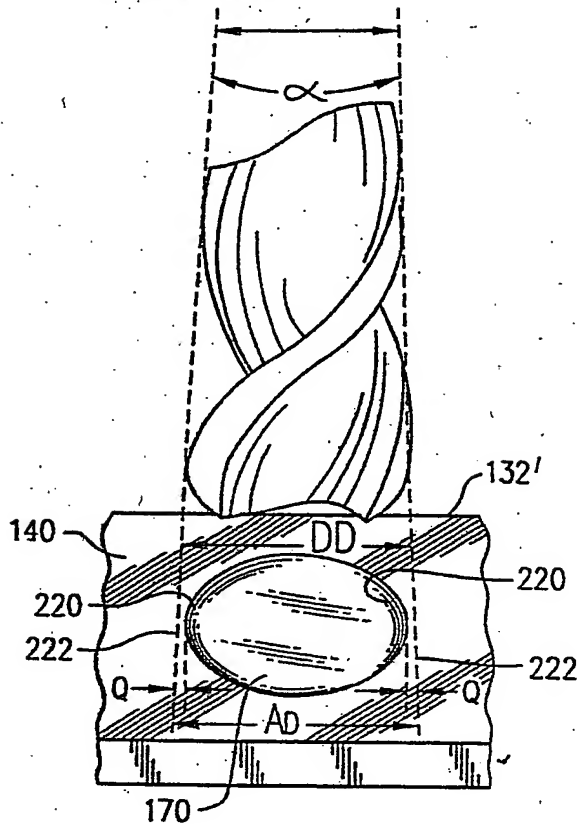


FIG. 22

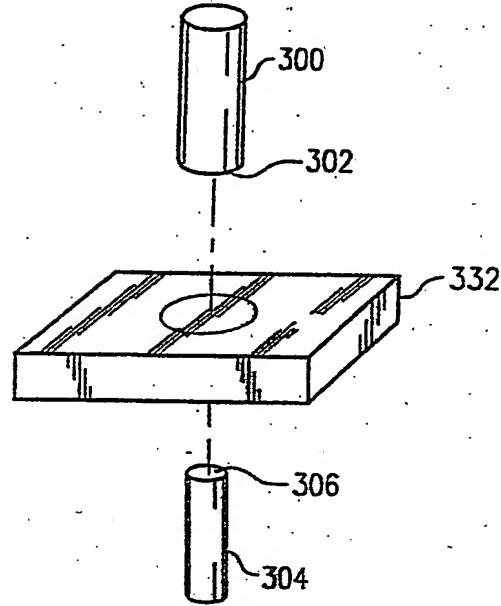


FIG. 24

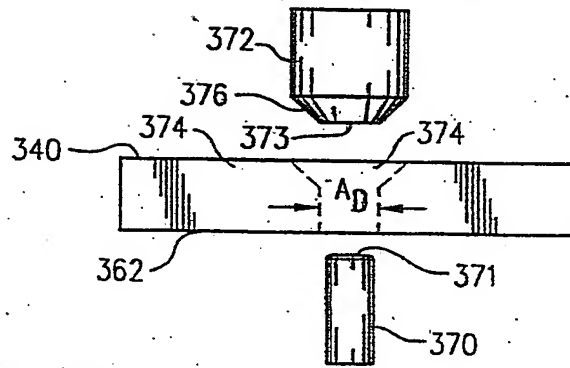


FIG. 23

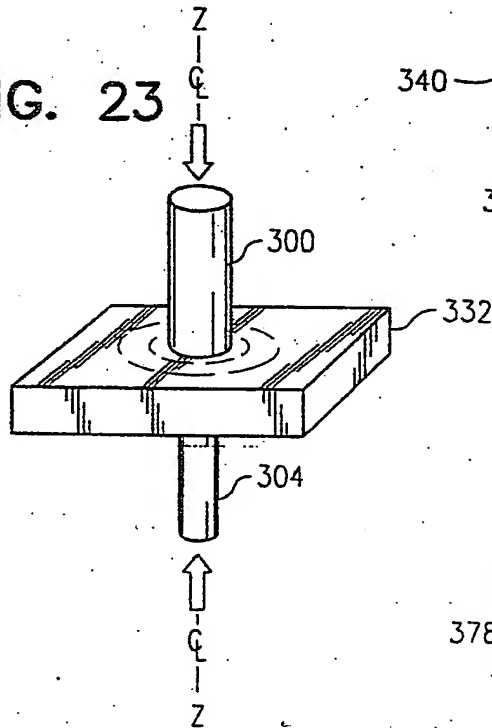
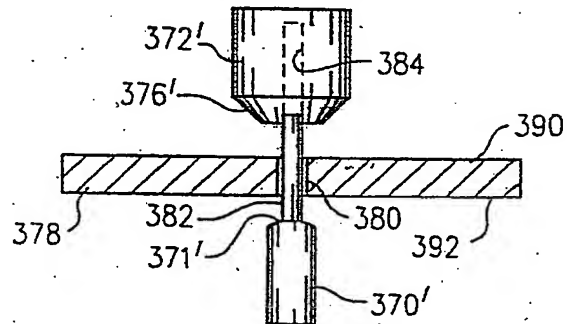


FIG. 25



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FIG. 26

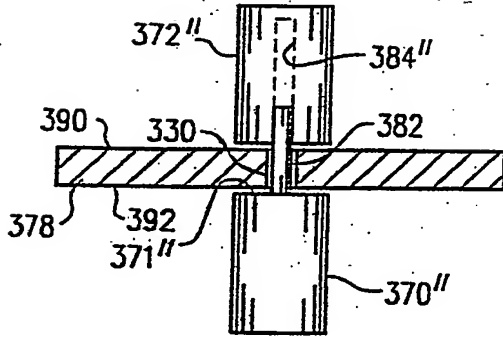


FIG. 27

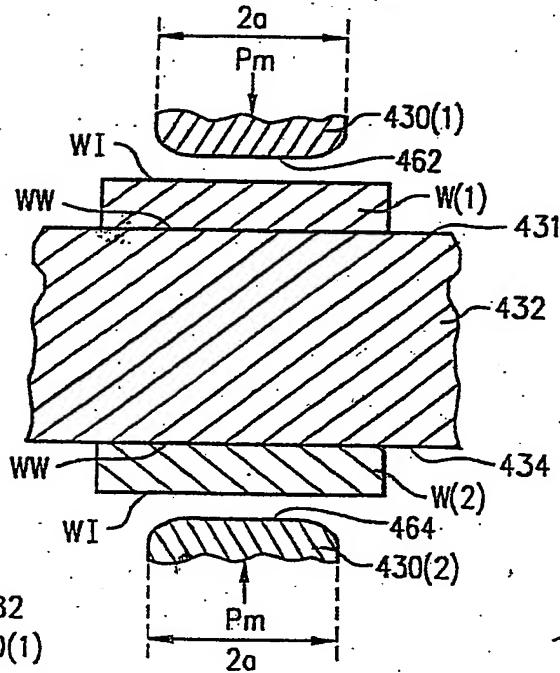


FIG. 28

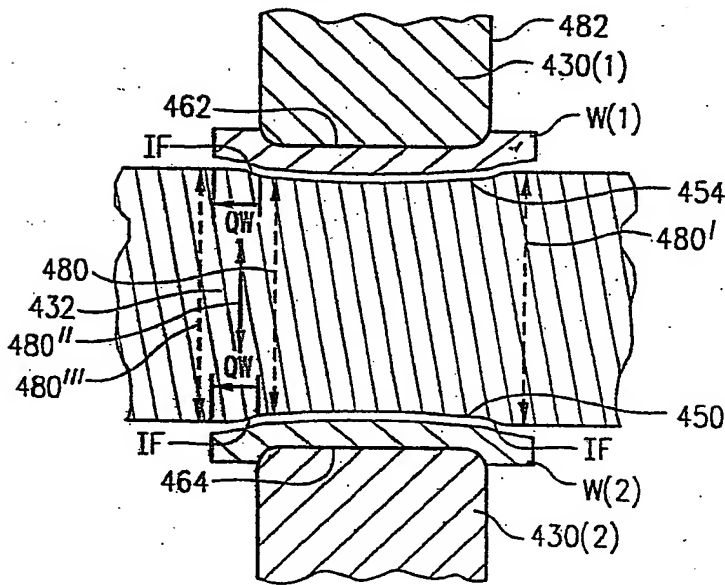


FIG. 31

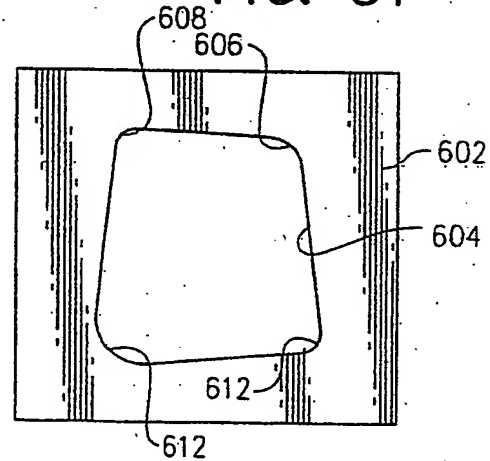
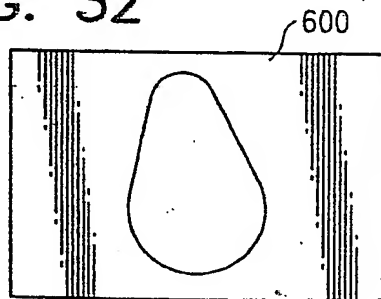


FIG. 32



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FIG. 29

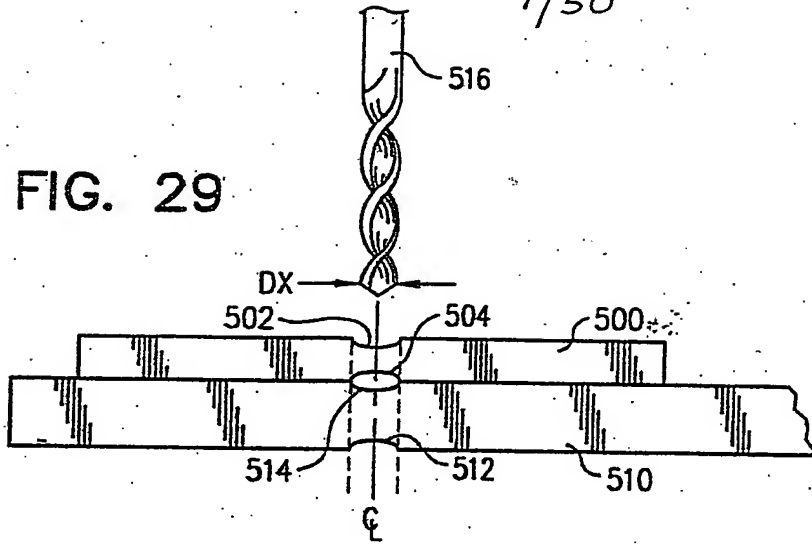


FIG. 33

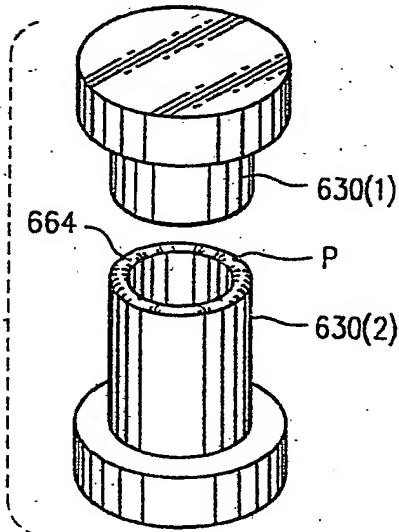


FIG. 30

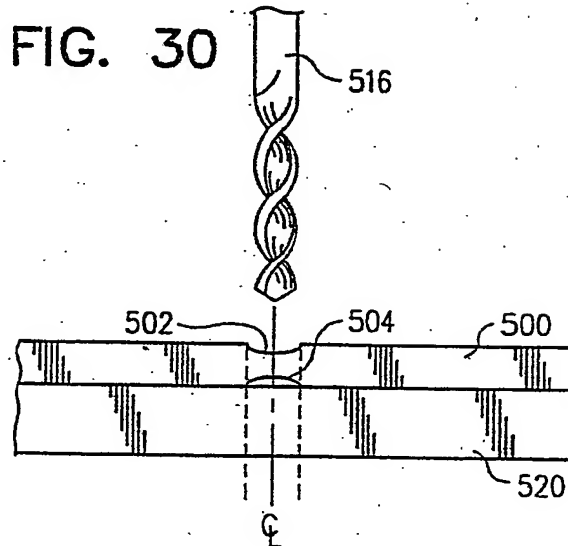
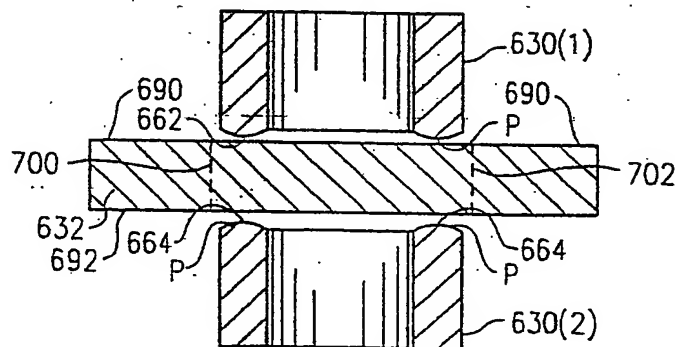


FIG. 34



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FIG. 35

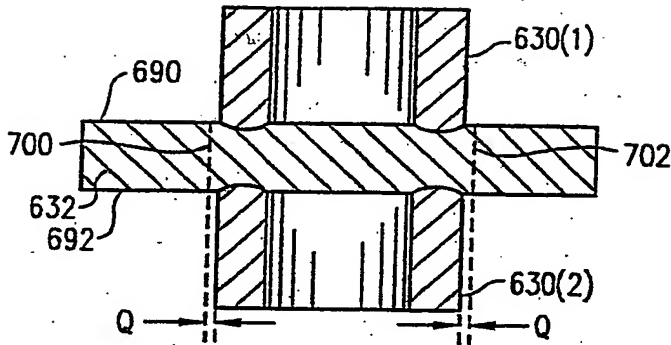


FIG. 36

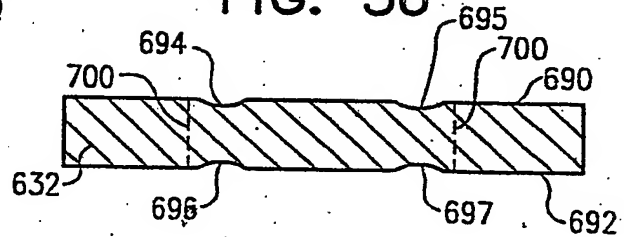


FIG. 37

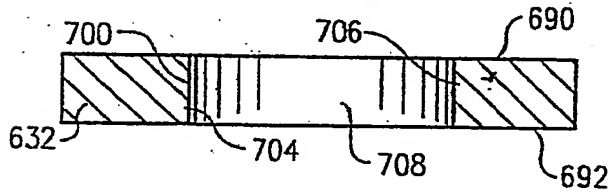


FIG. 48

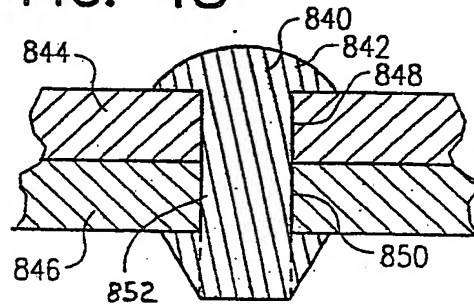
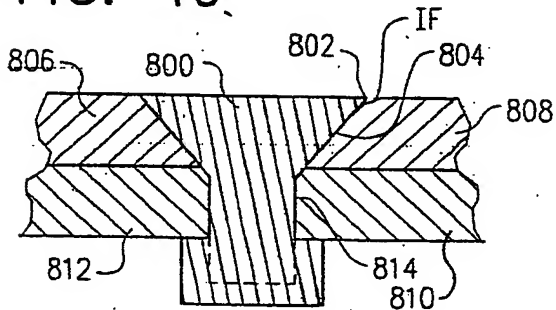


FIG. 49



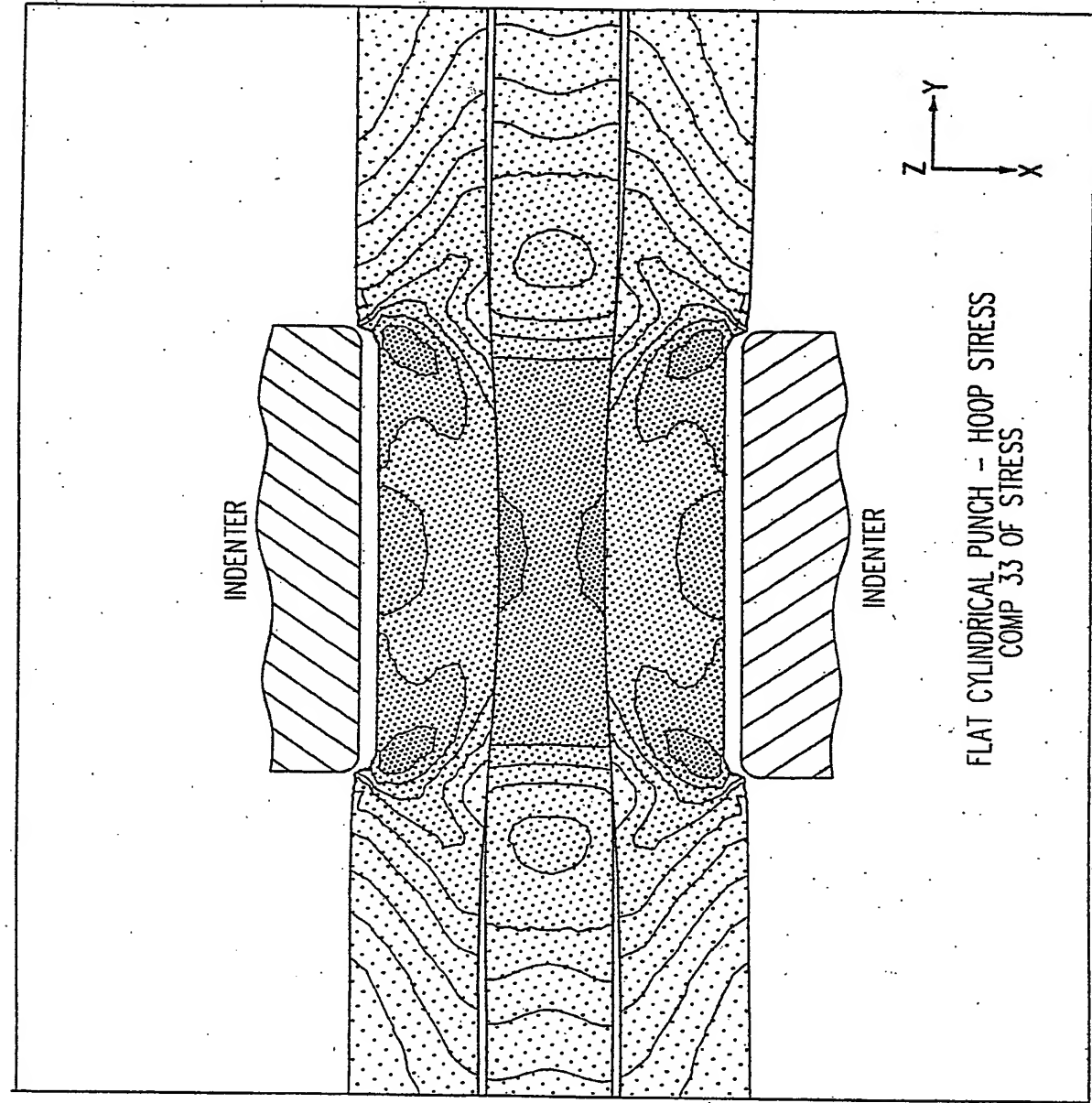
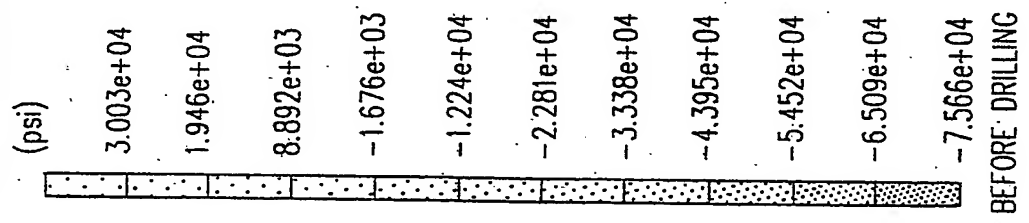
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FIG. 38

INC. 30
TIME: 2.000e+00



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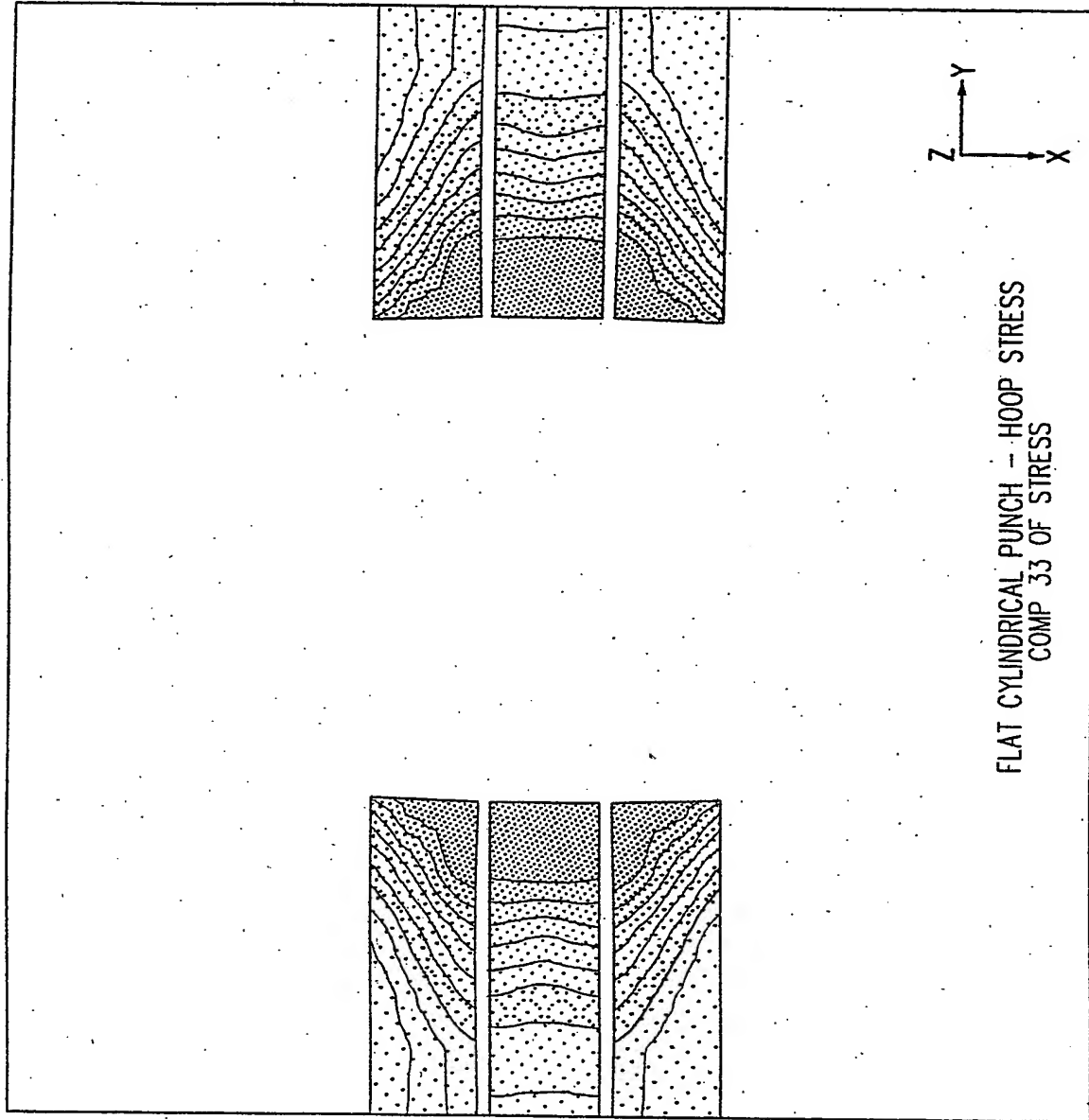
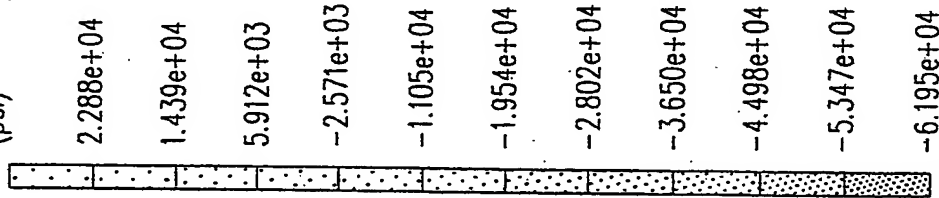


FIG. 39

INC: 40
 TIME: 4.000e+00

(psi)

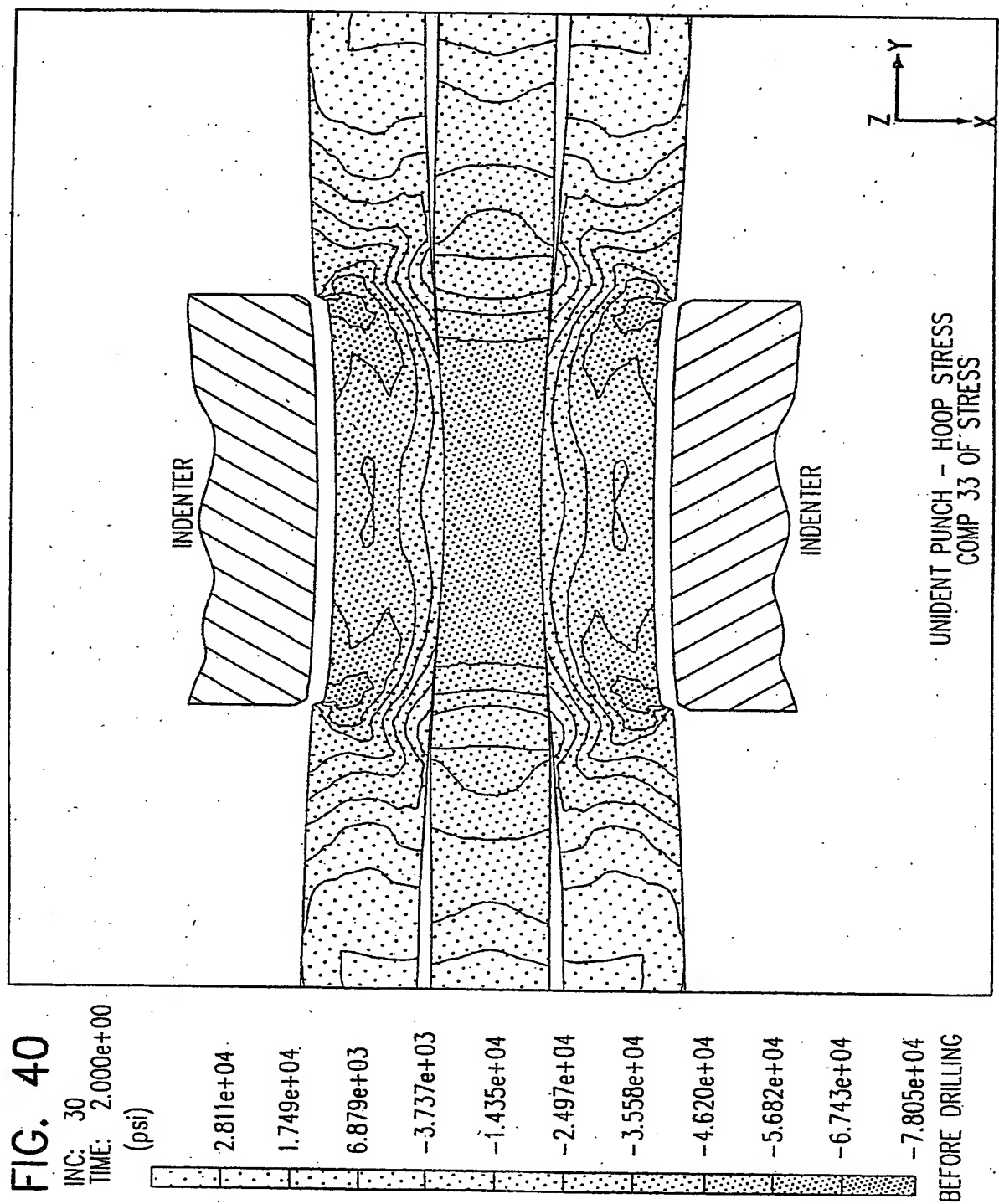


AFTER DRILLING

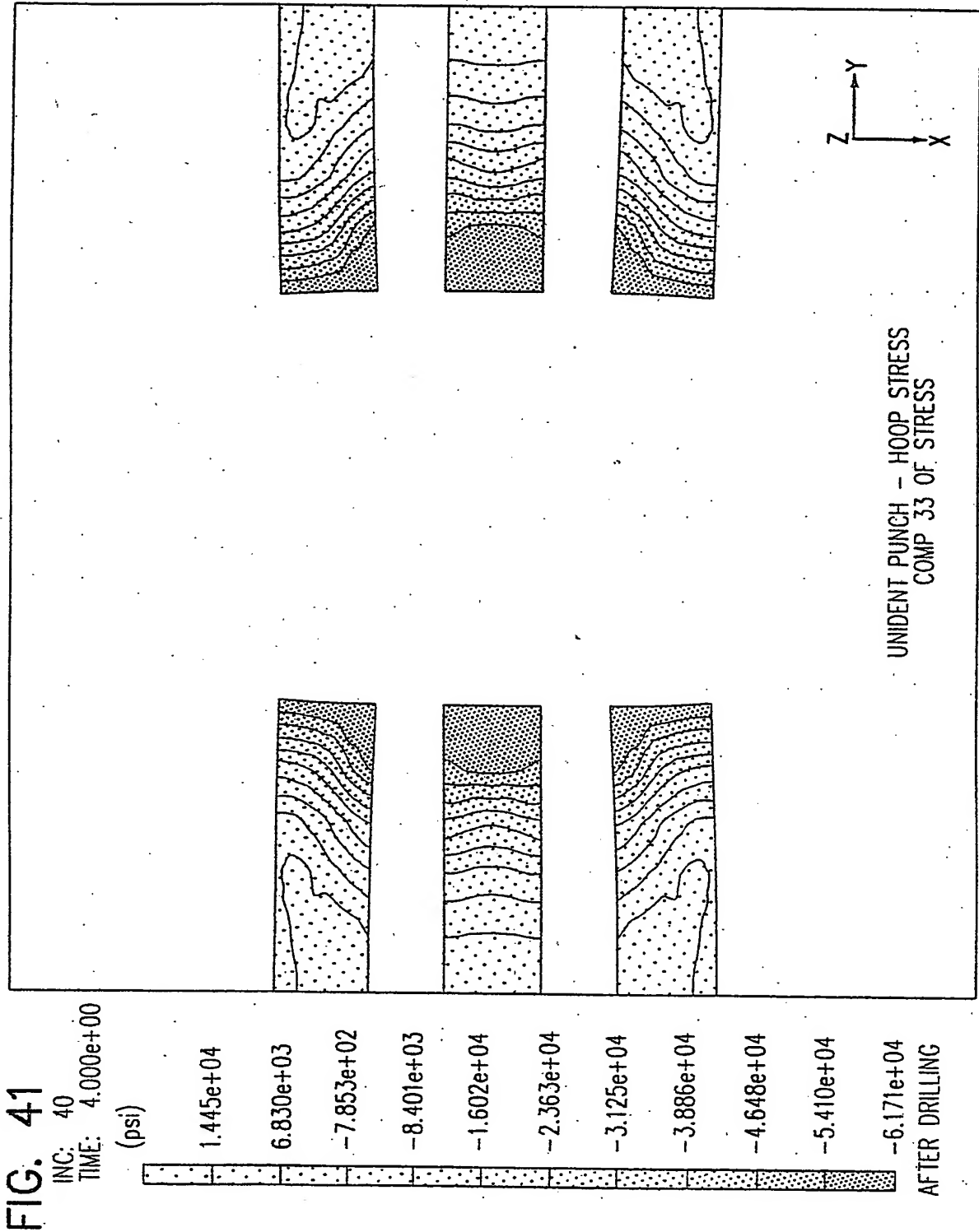
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2008EFO" 8049900T

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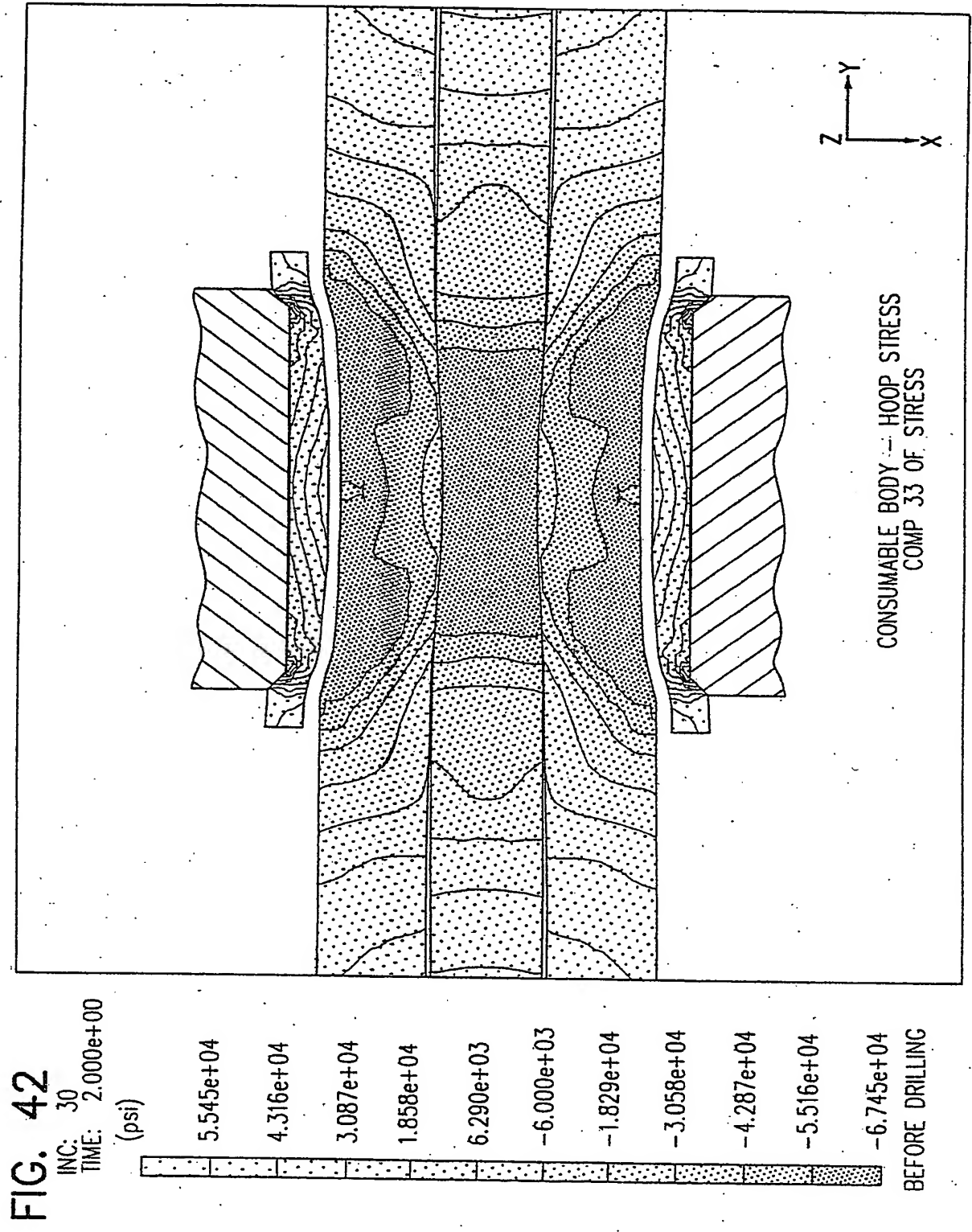
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200ETO" 8049900F

200ETO-8049900F

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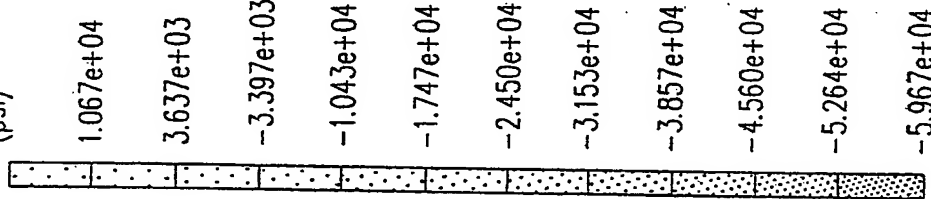


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FIG. 43

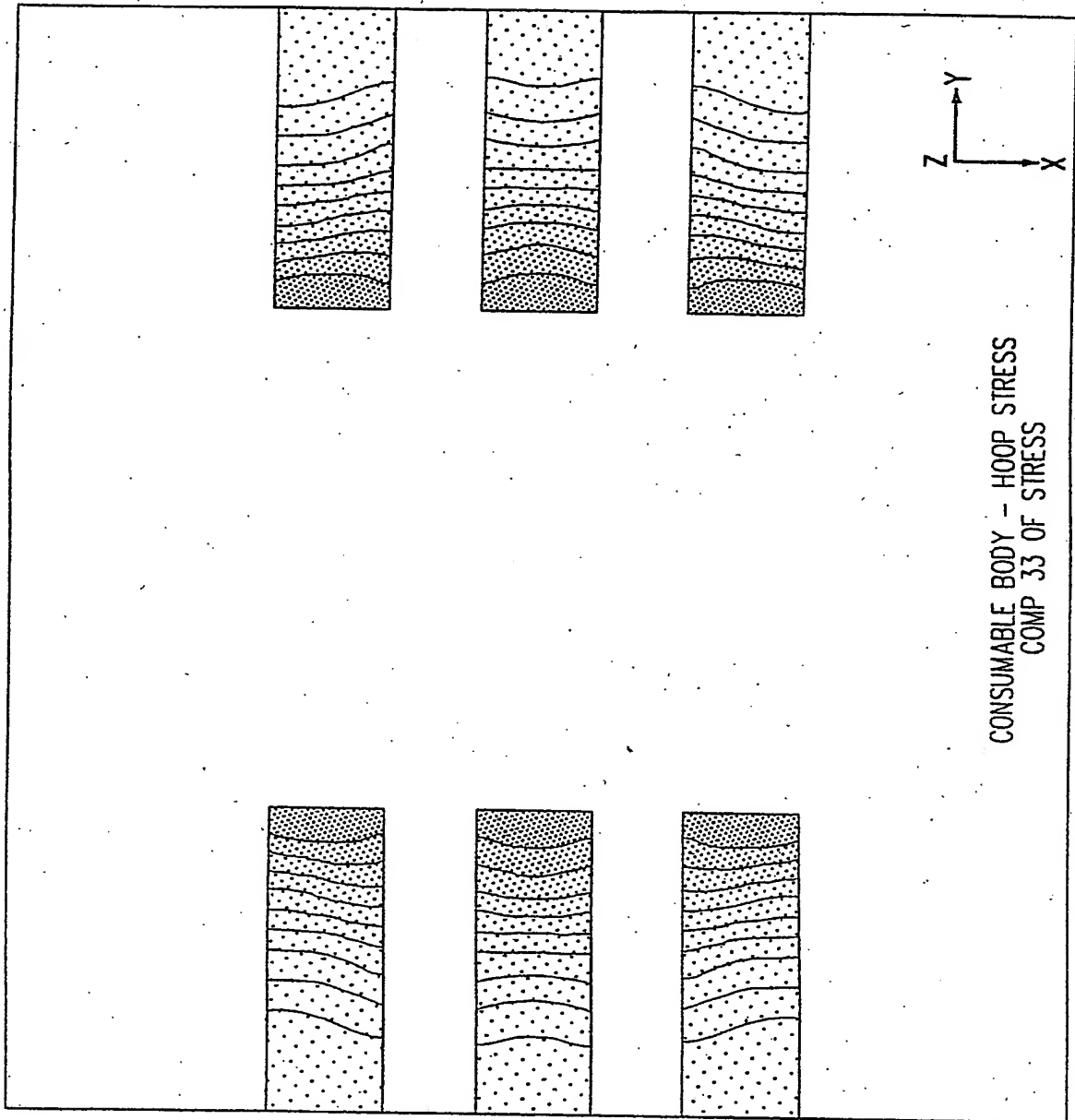
INC: 40
 TIME: 4.000e+00

(psi)



AFTER DRILLING

CONSUMABLE BODY - HOOP STRESS
 COMP 33 OF STRESS



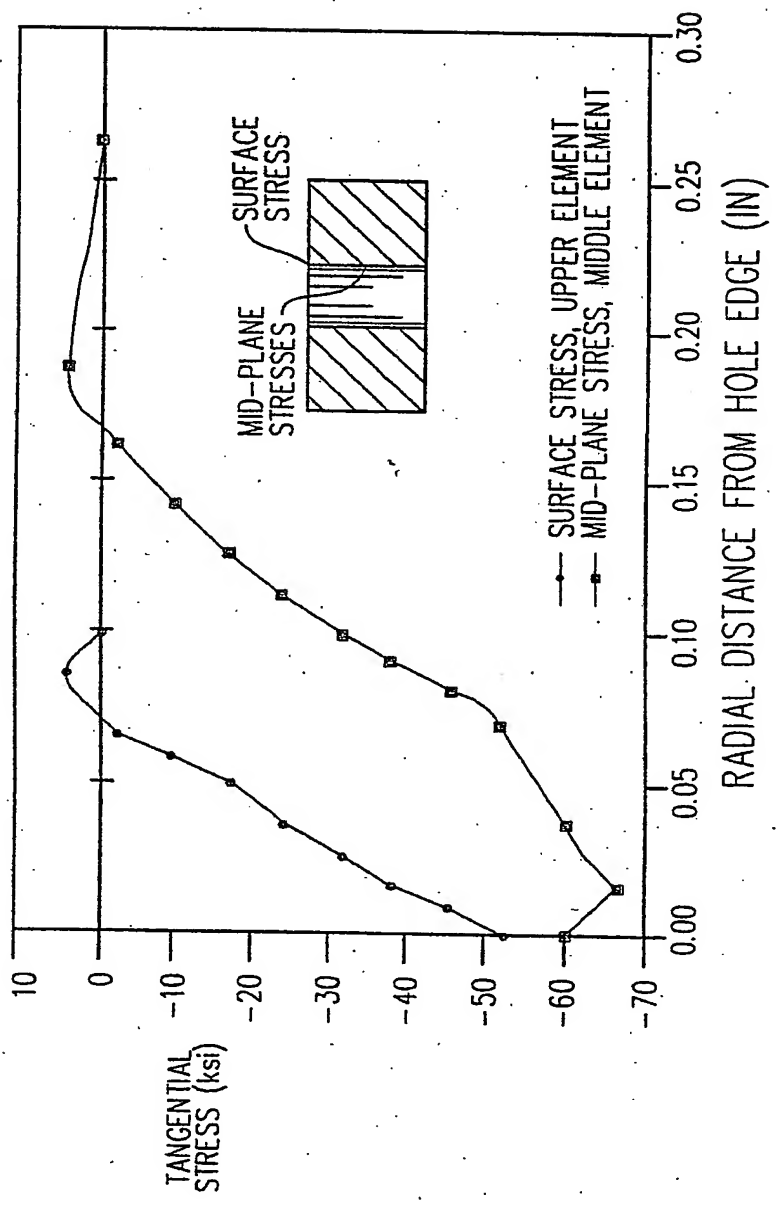
200EFO-80499007

200610" 8049900F

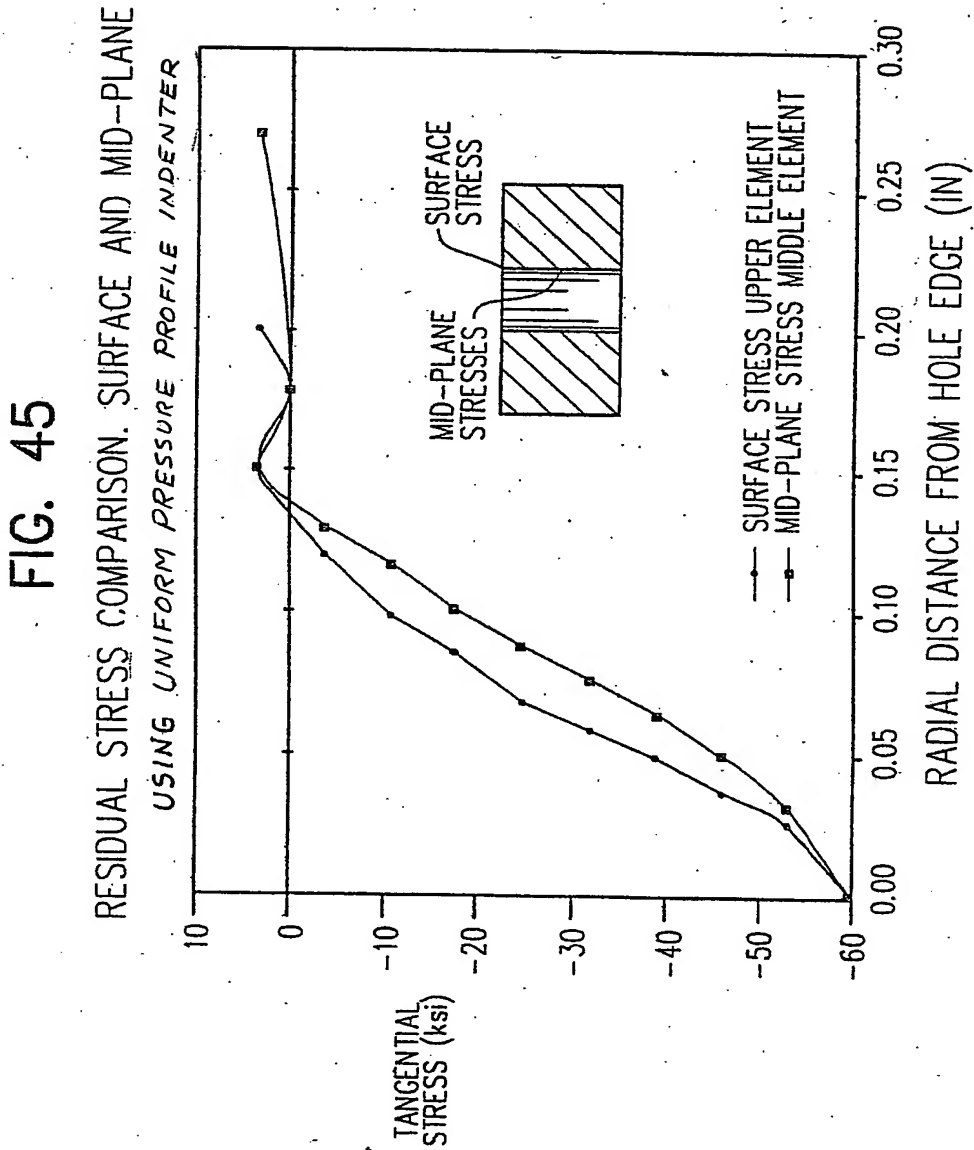
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FIG. 44
PRIOR ART

RESIDUAL STRESS COMPARISON, SURFACE AND MID-PLANE
FLAT BOTTOMED CYLINDRICAL MANDREL



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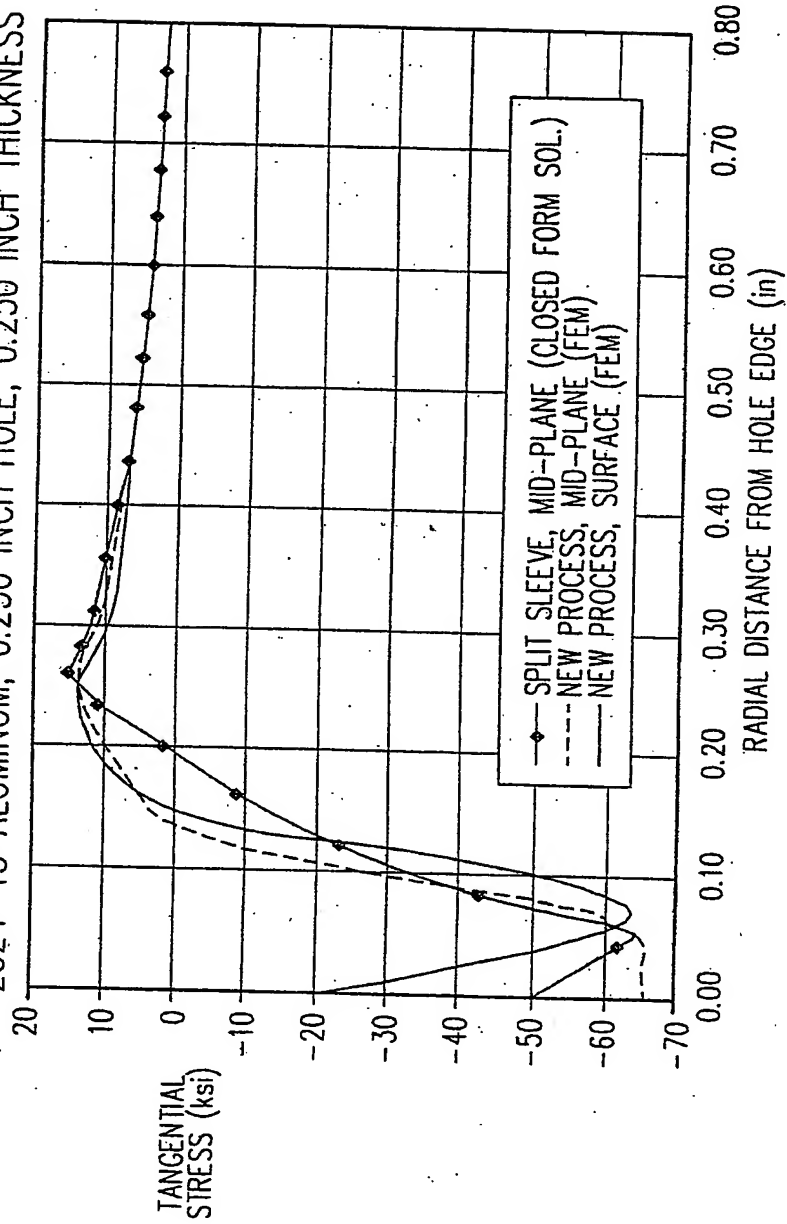


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FIG. 46

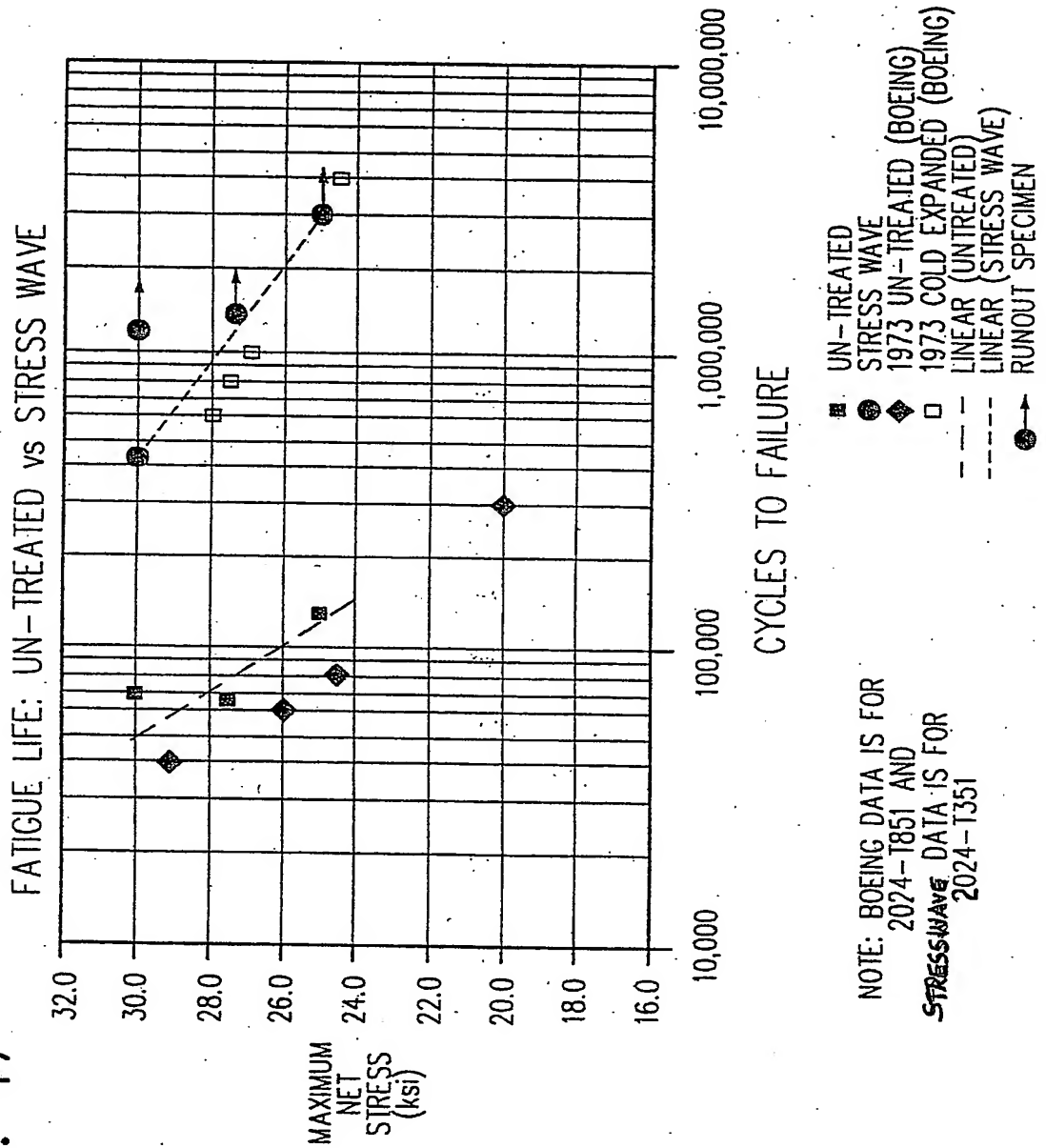
RESIDUAL STRESSES COMPARISON, NEW PROCESS vs SPLIT SLEEVE,
2024-T3 ALUMINUM, 0.250 INCH HOLE, 0.250 INCH THICKNESS



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FIG. 47



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FIG. 50

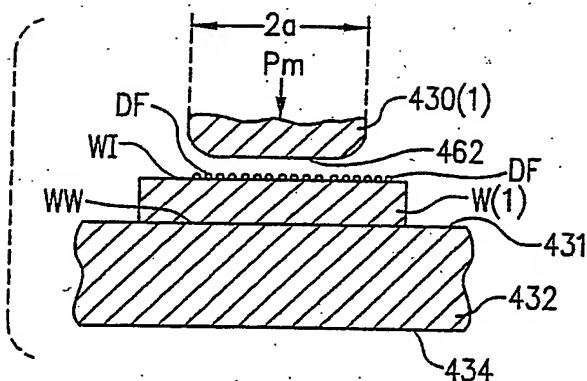


FIG. 52

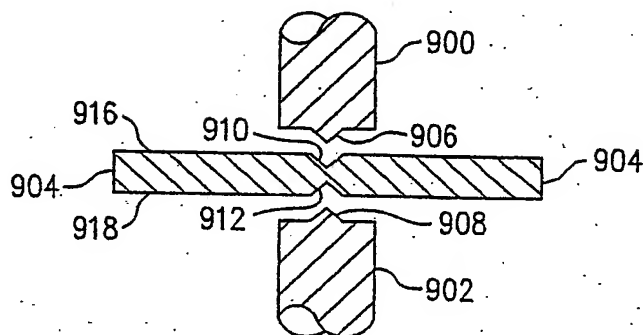


FIG. 53

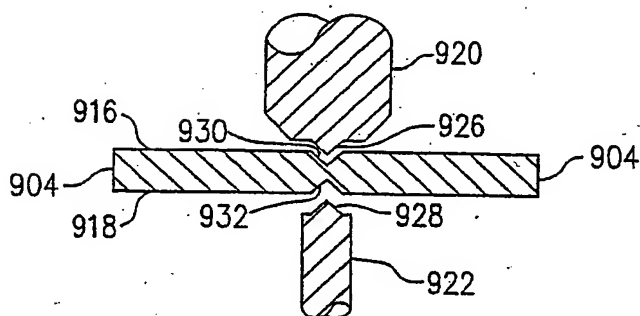
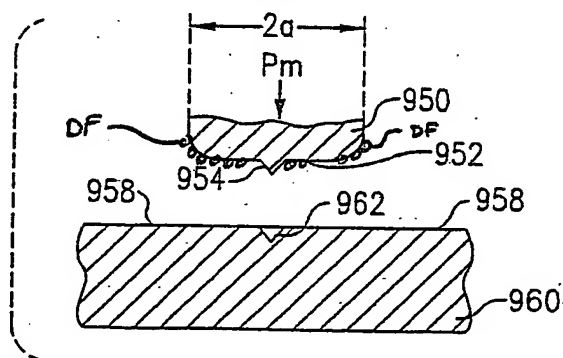


FIG. 54



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FIG. 51

FIG. 51A

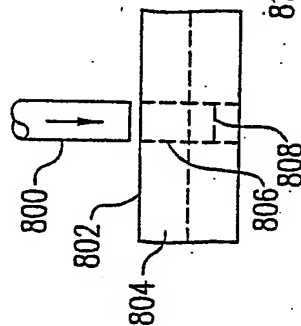


FIG. 51B

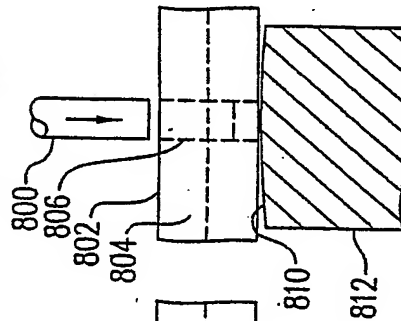


FIG. 51C

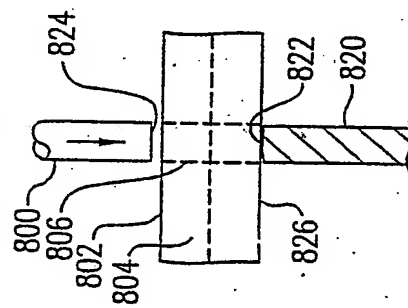


FIG. 51D

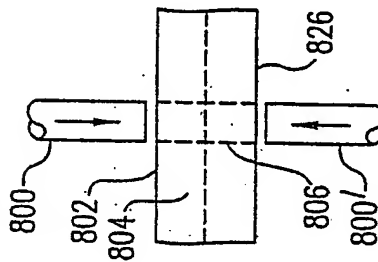
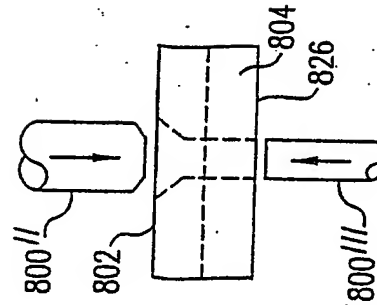


FIG. 51E



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FIG. 55

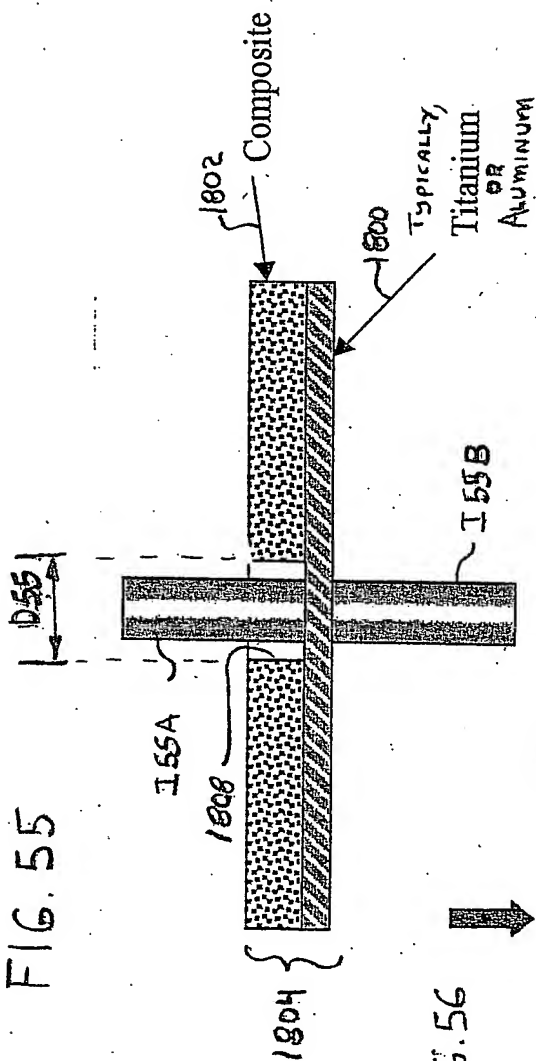
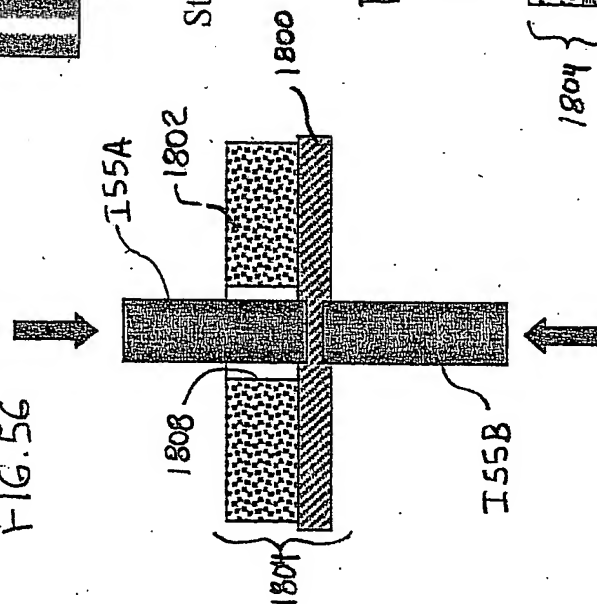


FIG. 56



Stack up is matched drilled after processing

FIG. 57

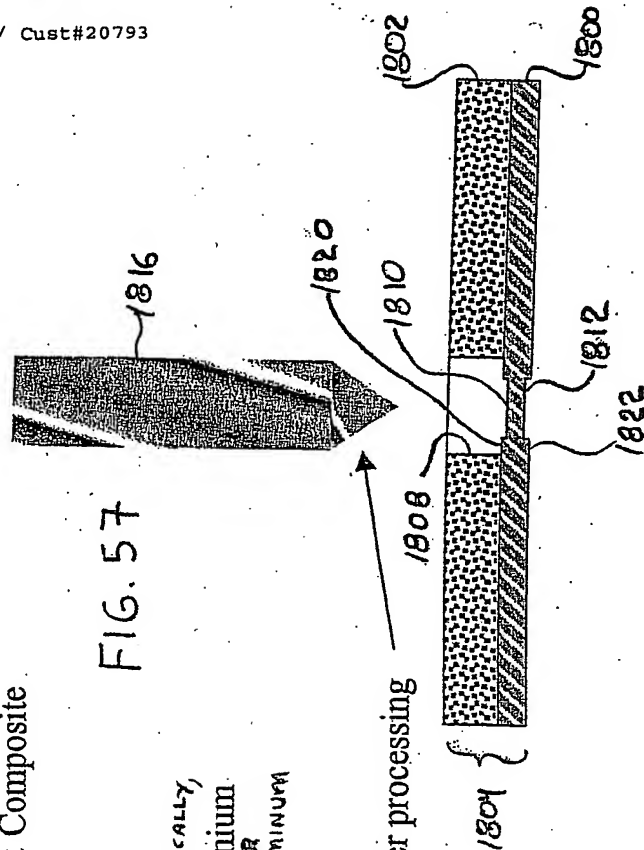
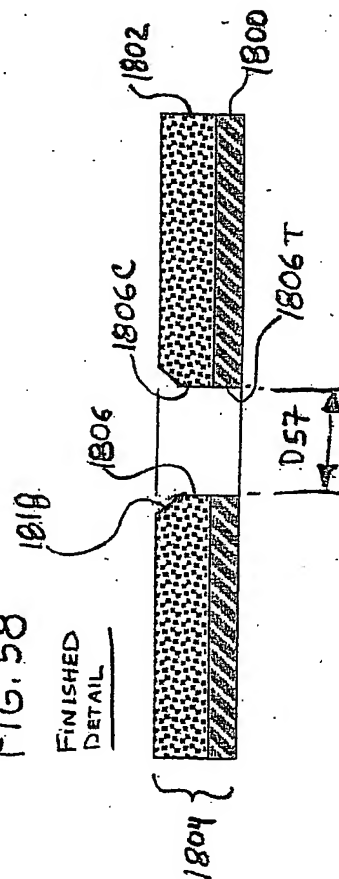


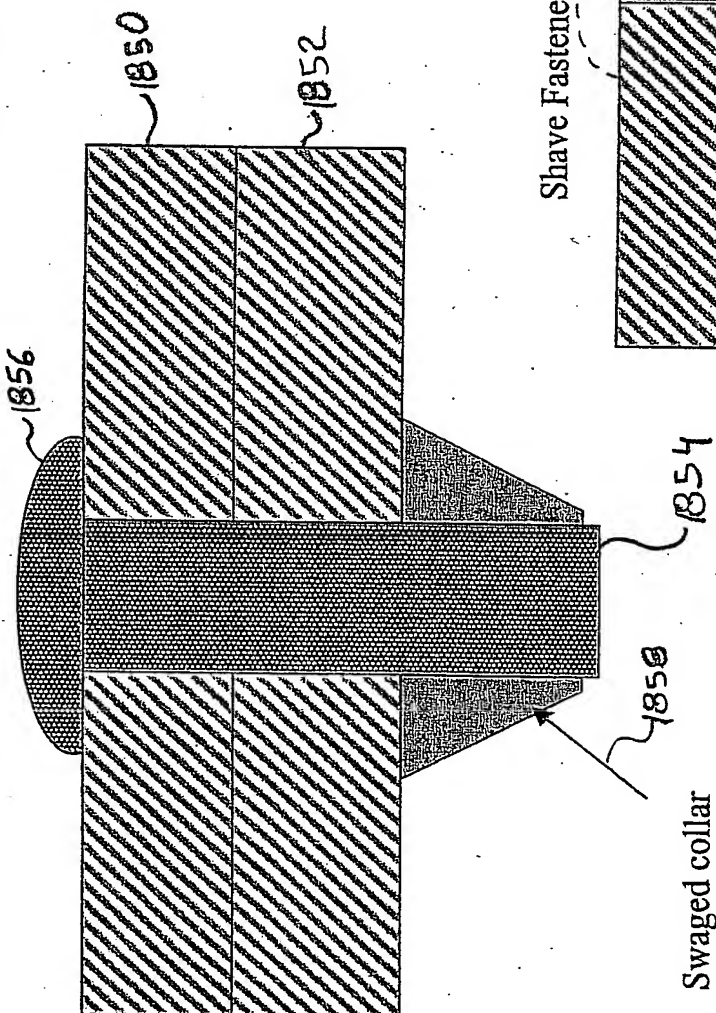
FIG. 58



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FIG. 59

Temporary (Tack) fastener configuration



Shave Fastener head off

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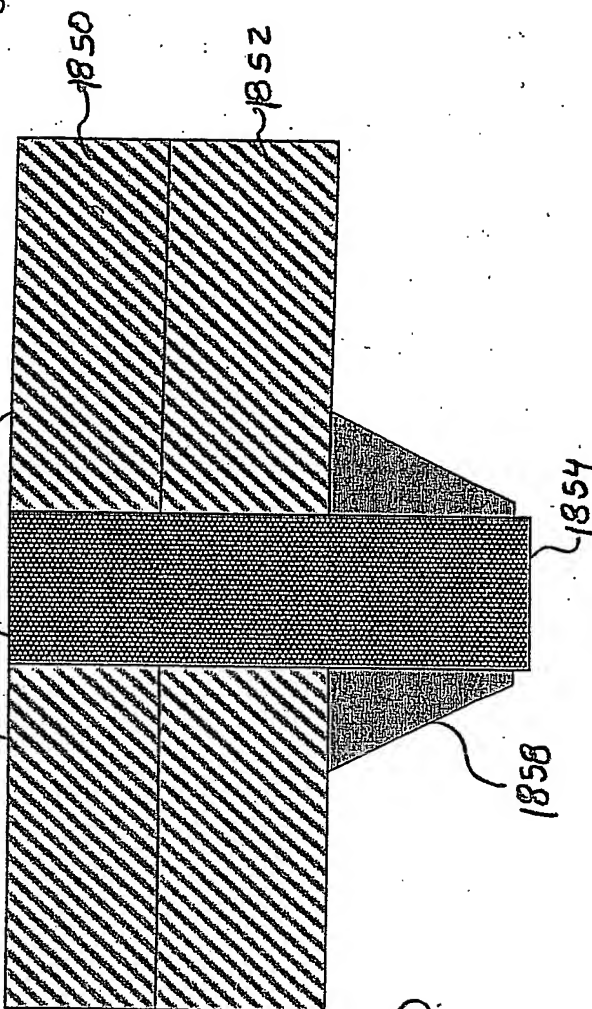


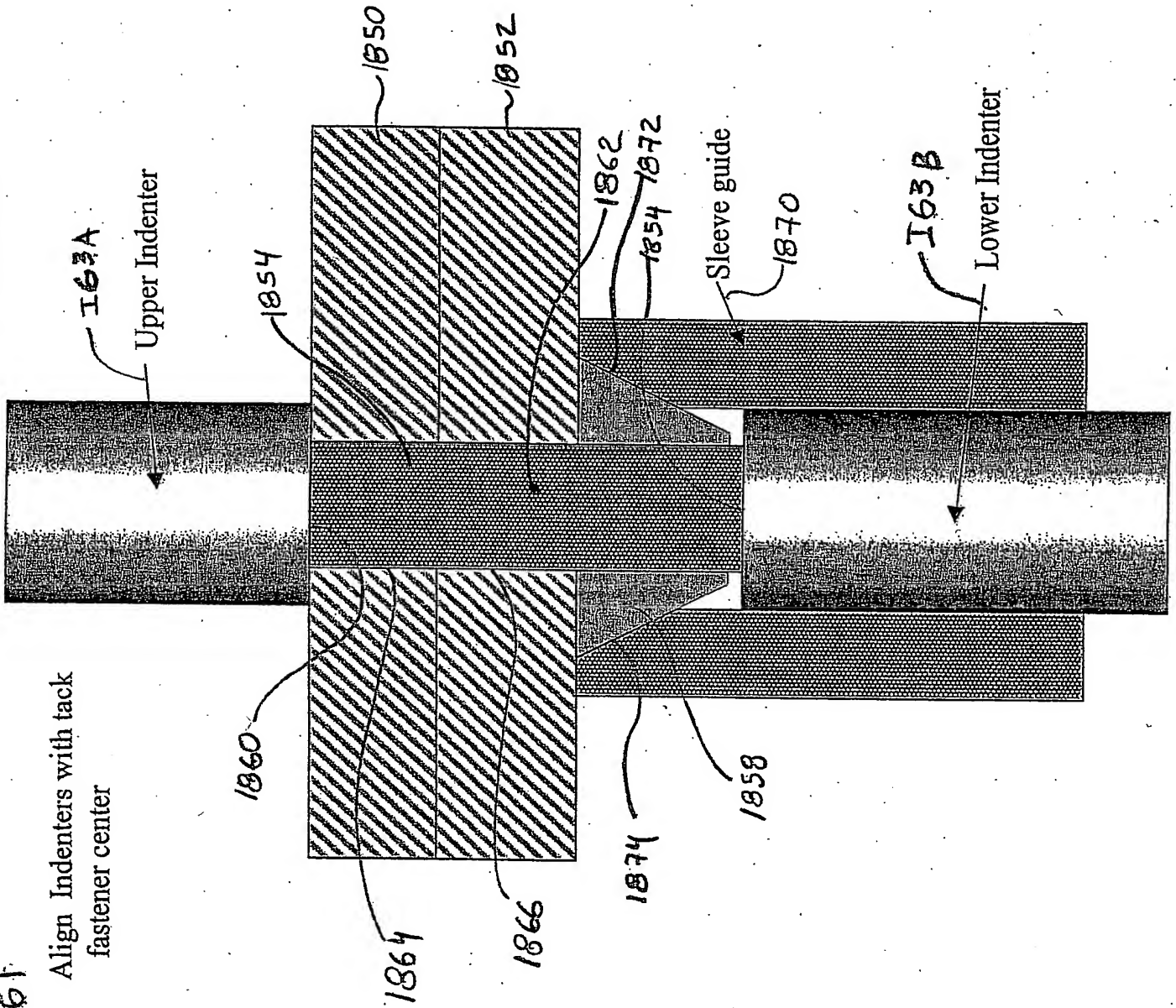
FIG. 60

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FIG. 6f

Align Indenters with tack
fastener center



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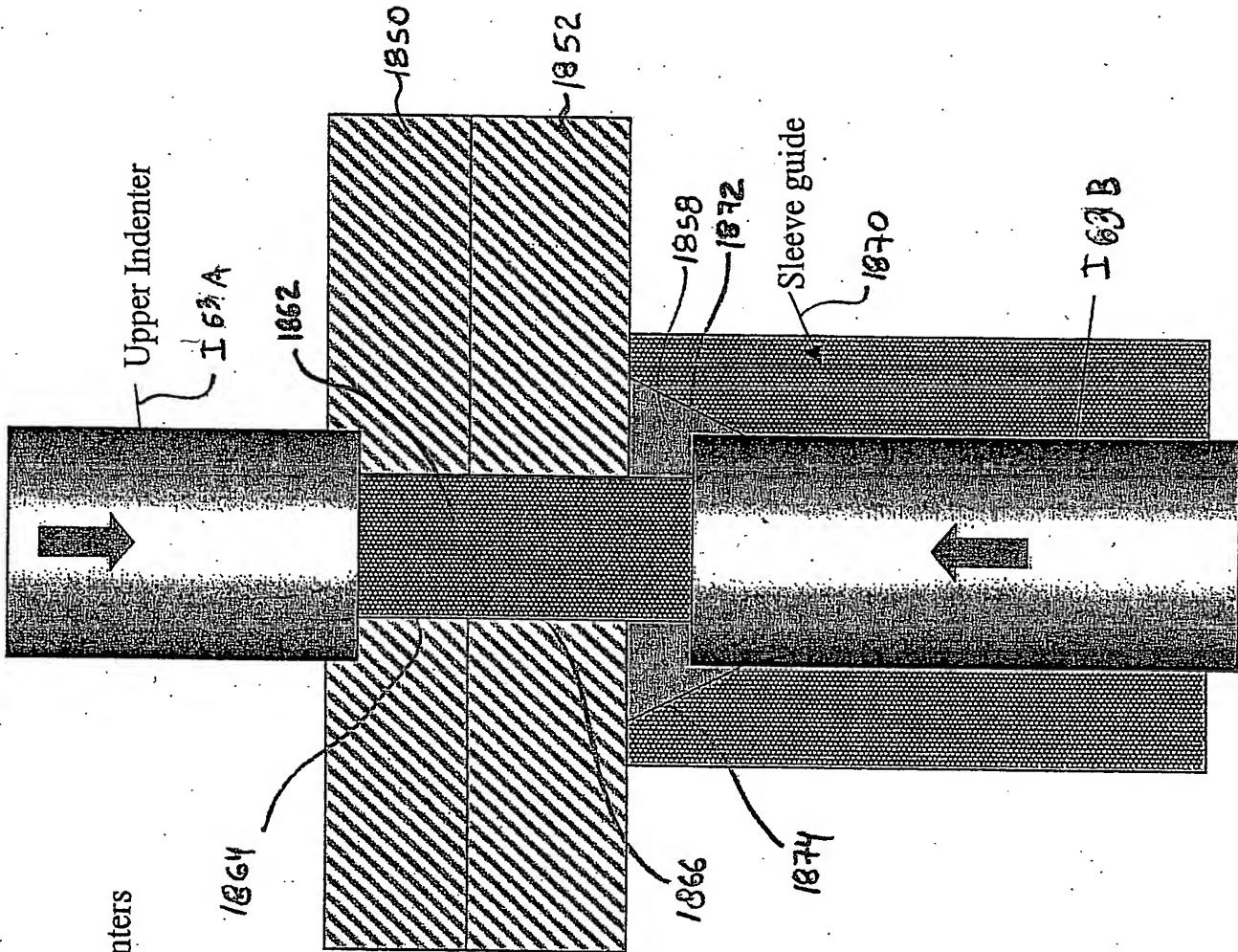


FIG. 62

Actuate Indenters

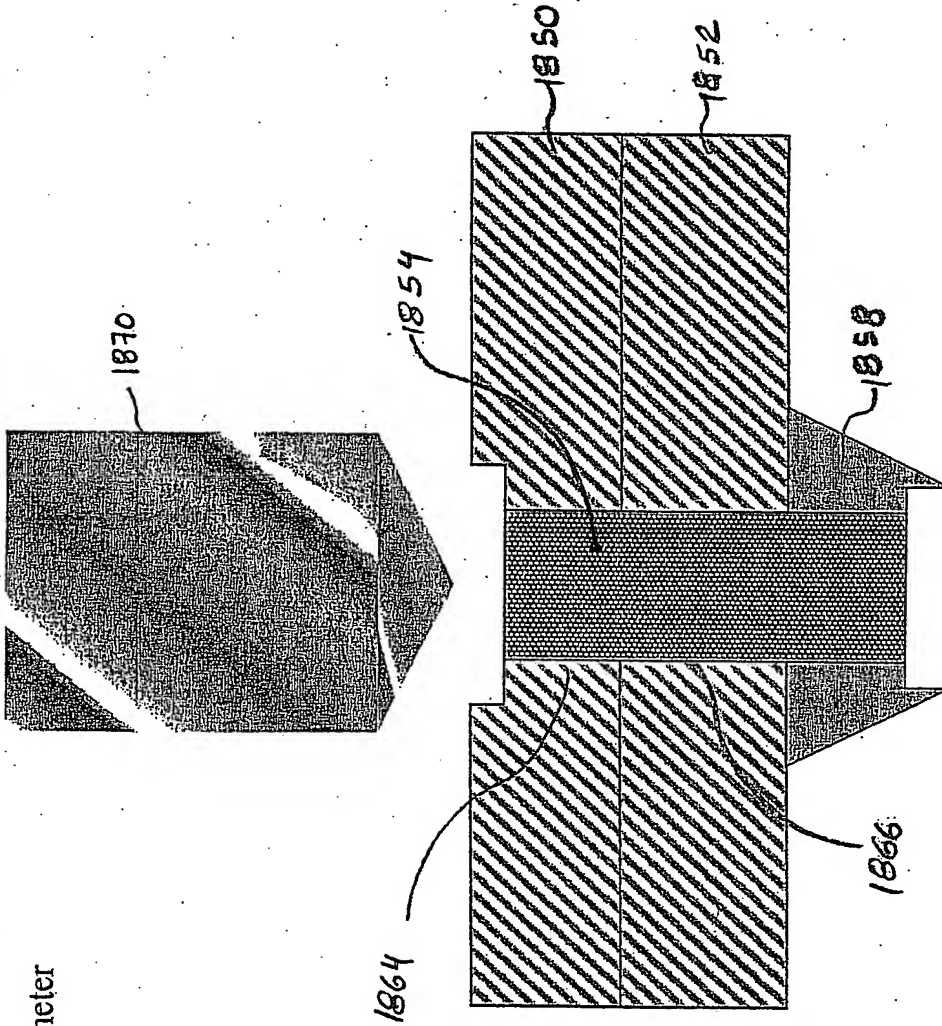
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FIG. 63

Drill to bolt diameter



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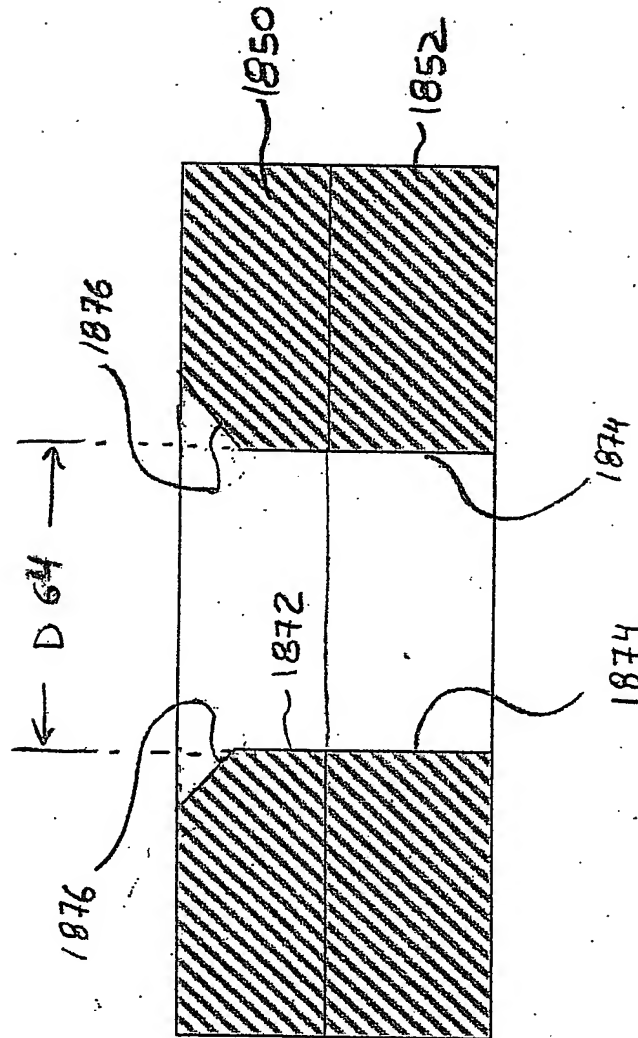


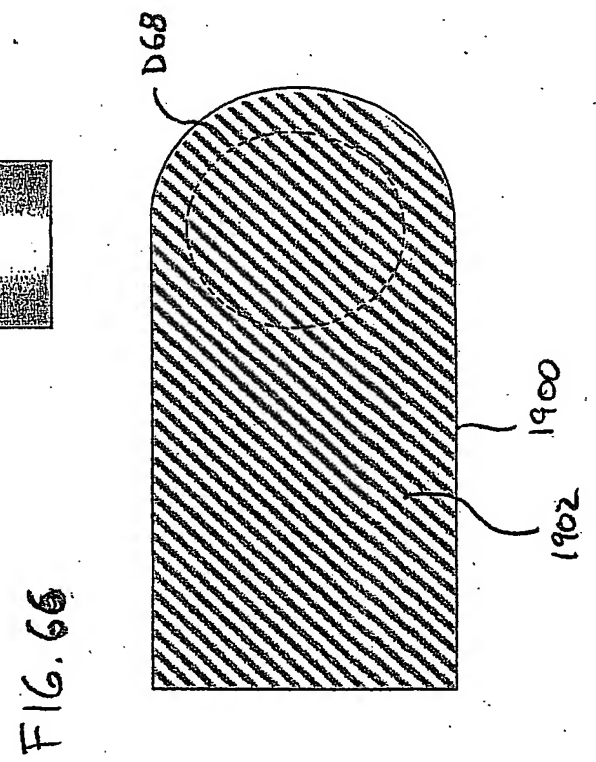
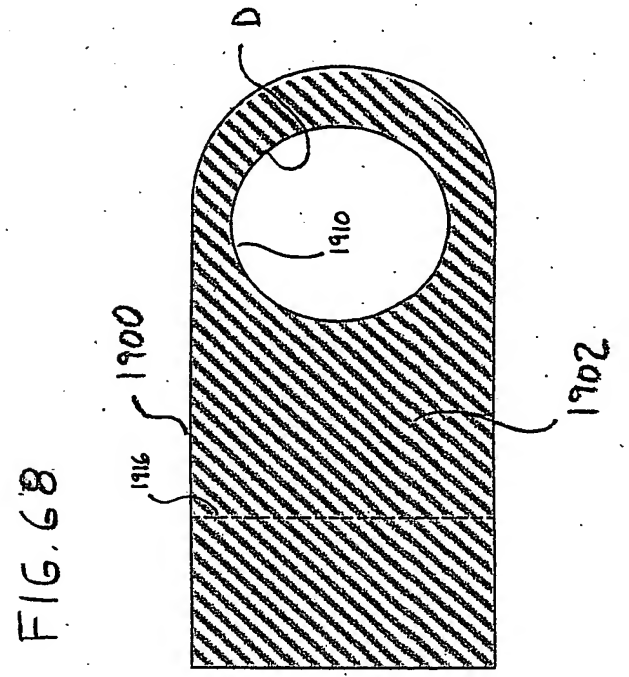
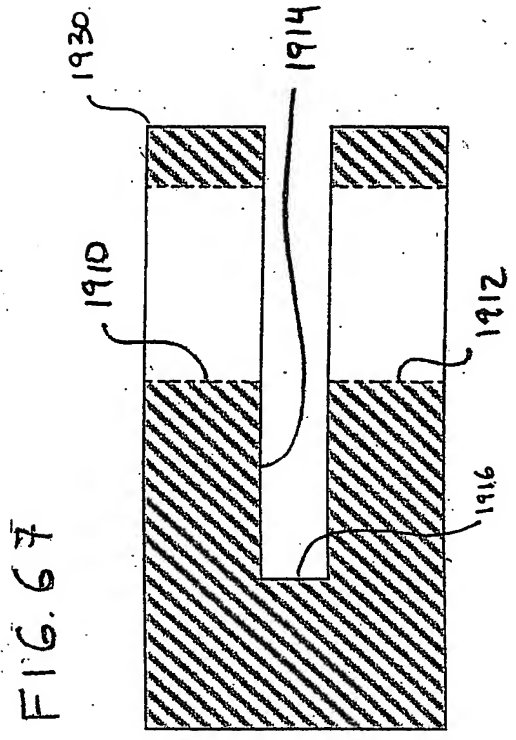
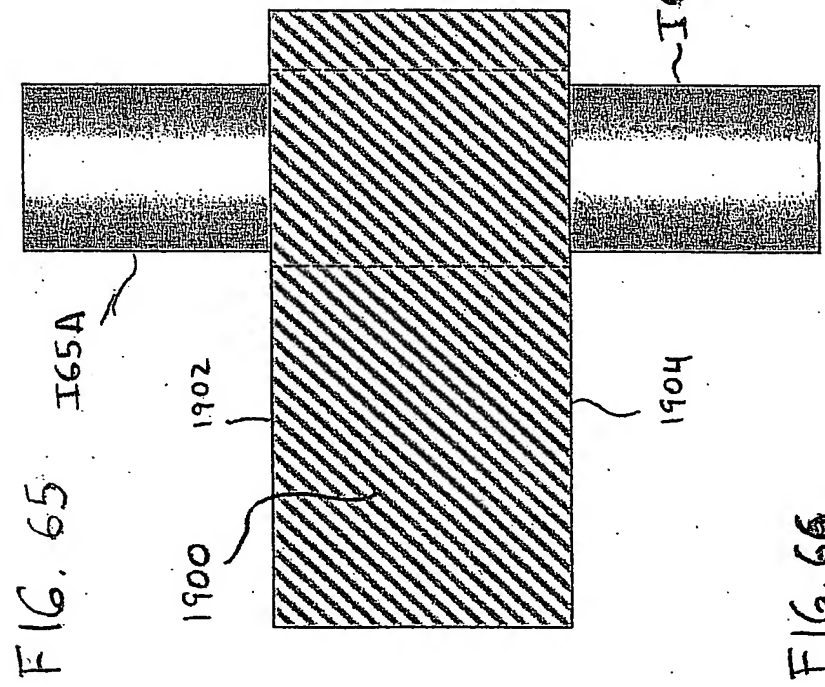
FIG. 64

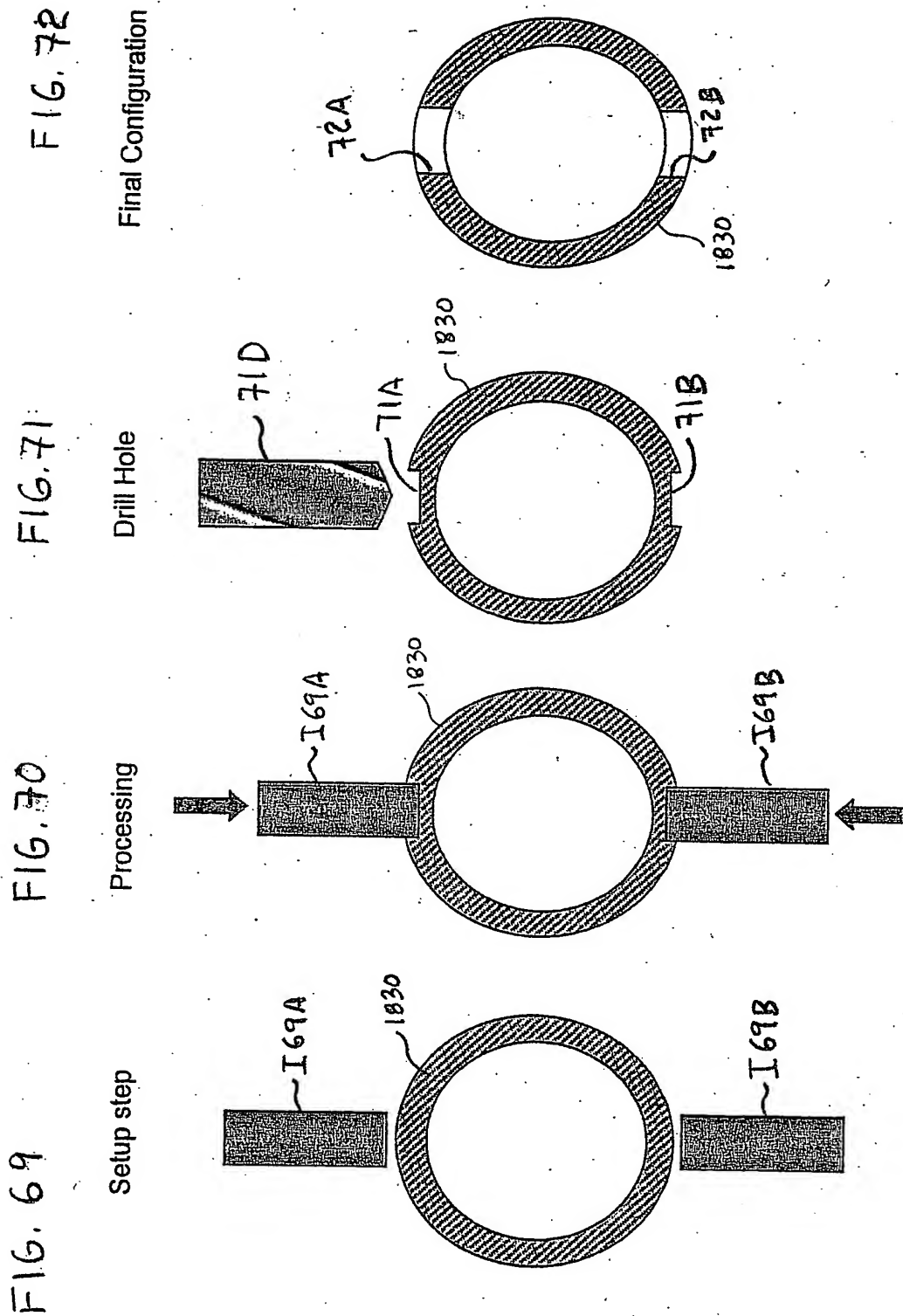
Finished treated hole

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Treatment of a tubular bar without internal support

FIG. 73

Cross-Sectional view of processing step

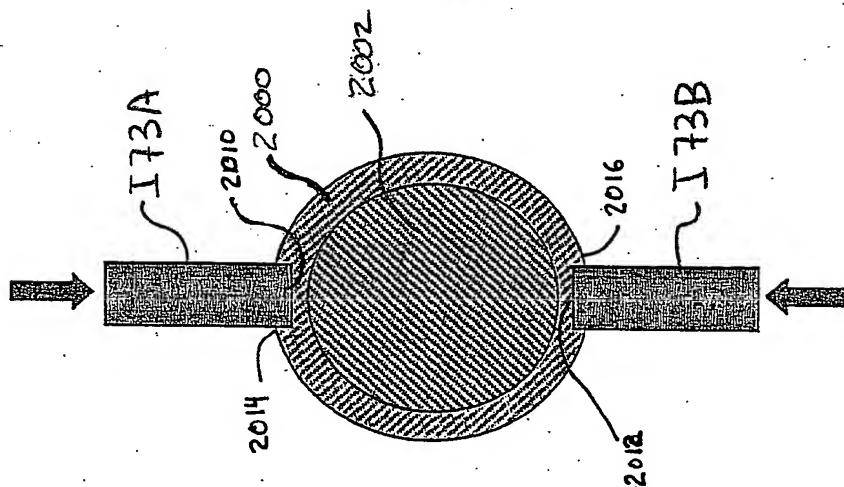
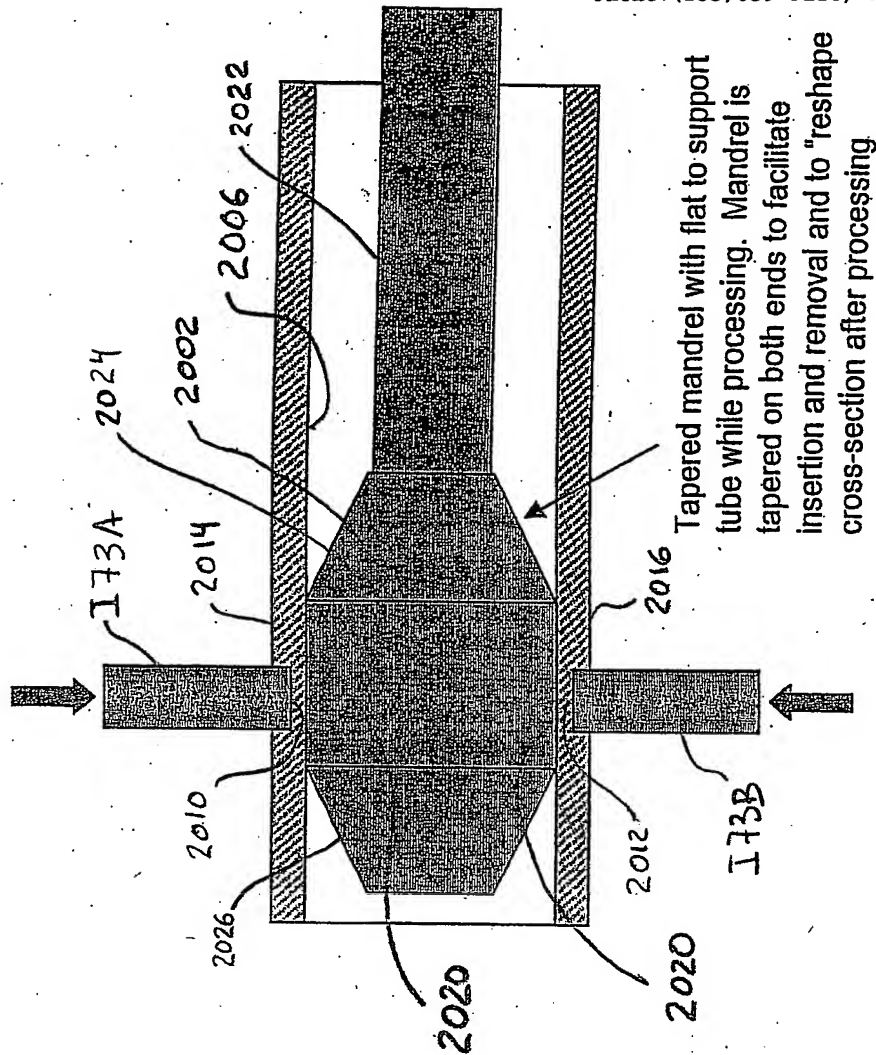


FIG. 74

Longitudinal cross-sectional view of processing step



Treatment of a tubular bar with internal support

Cross section of hollow tube treated with indenter end shape that conforms to tube diameter

FIG. 75

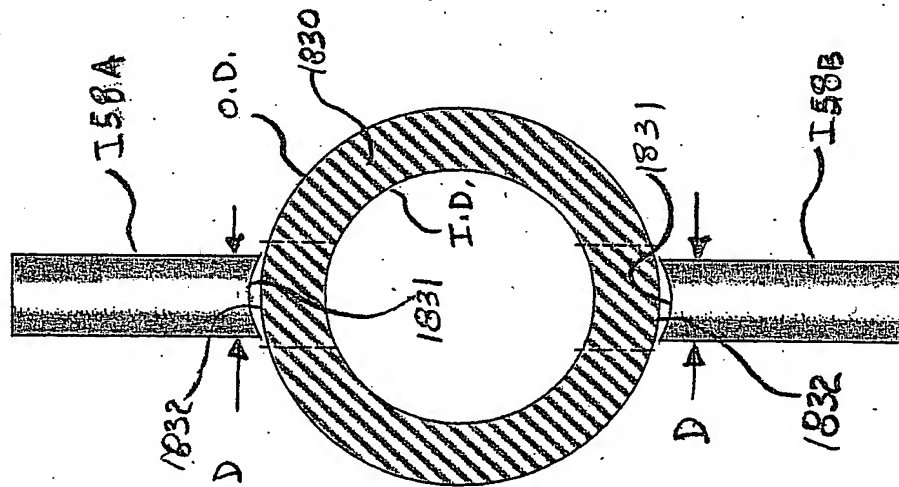
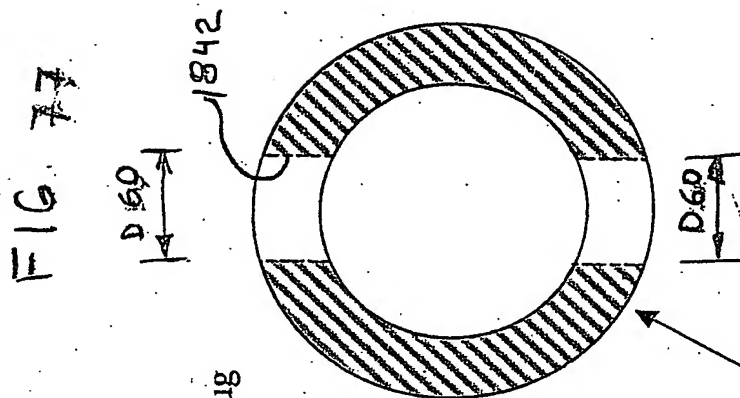
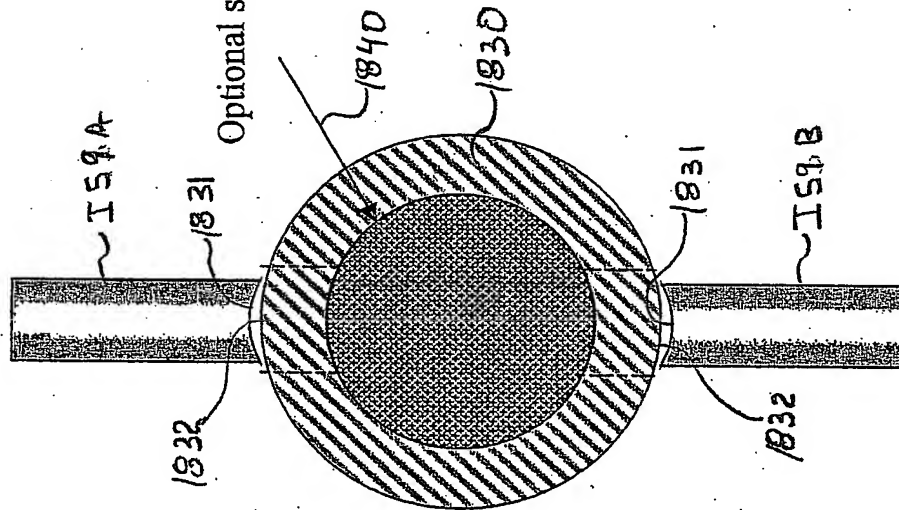


FIG. 76



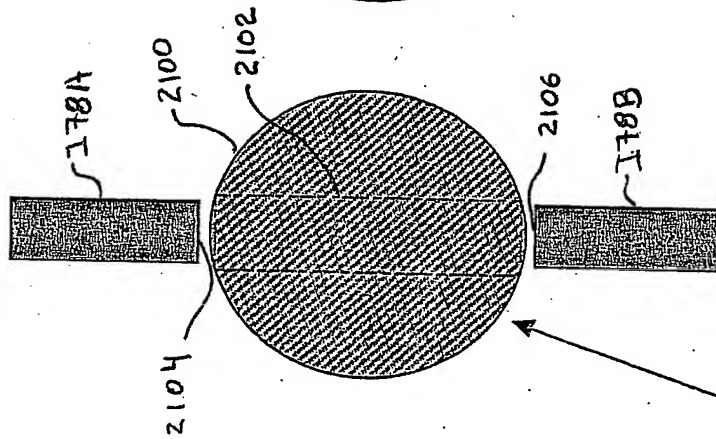
Cross section of finished workpiece after machining holes

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FIG. 78

Setup step



Cross section of round bar

FIG. 79

Processing

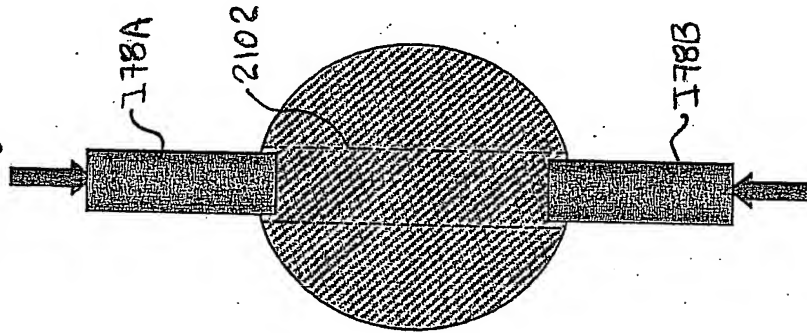


FIG. 80

Drill Hole

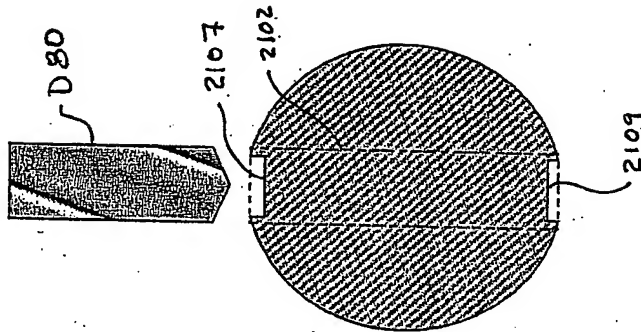


FIG. 81

Final Configurations

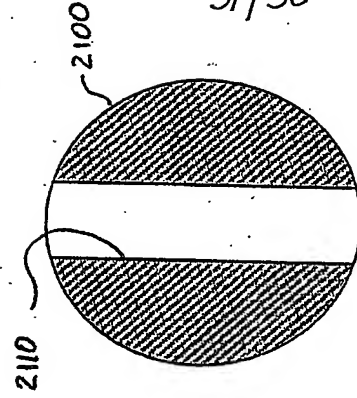
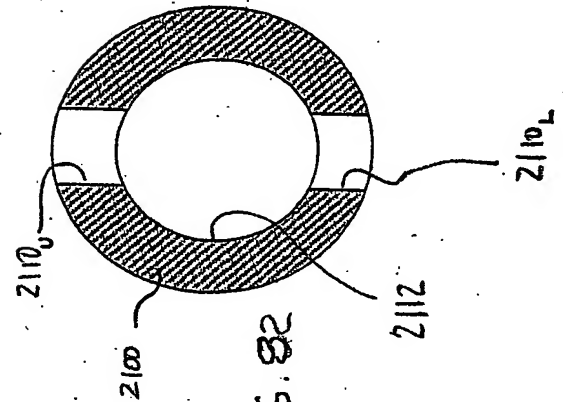


FIG. 82



Treatment of a solid bar

FIG. 83

Setup step

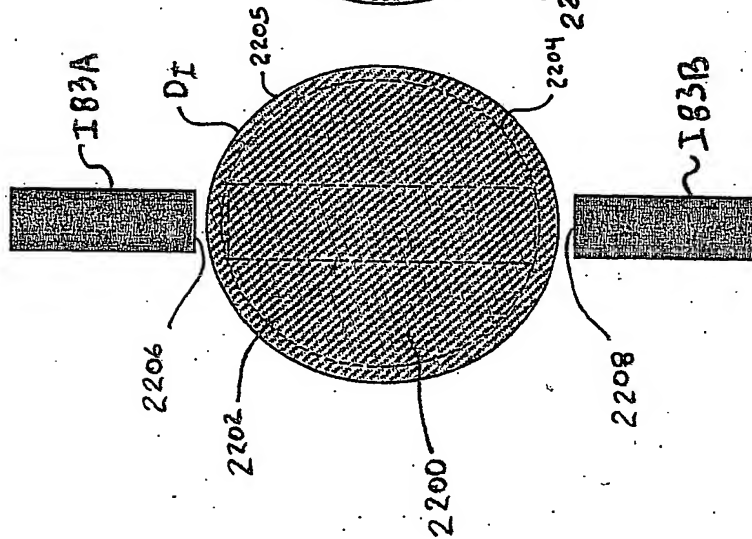


FIG. 84

Processing

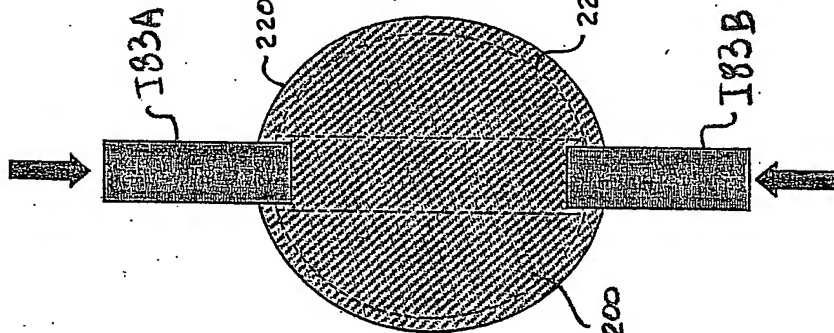


FIG. 85

Drill Hole

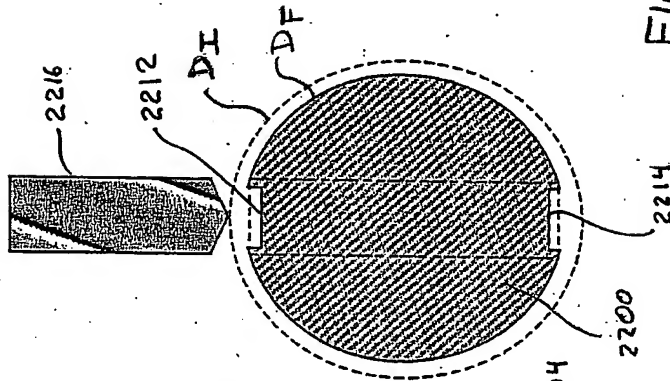


FIG. 86

Final Configurations

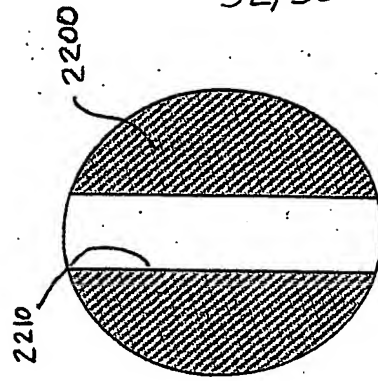
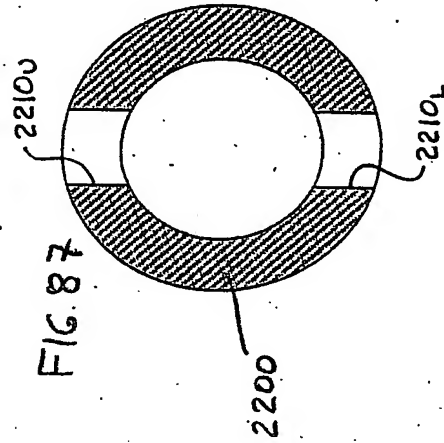


FIG. 87



Treatment of an initially oversized solid bar

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FIG. 88

Setup step

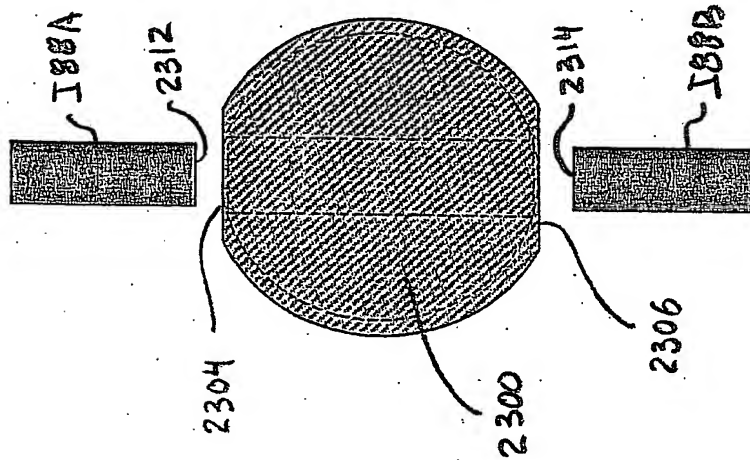


FIG. 89

Processing

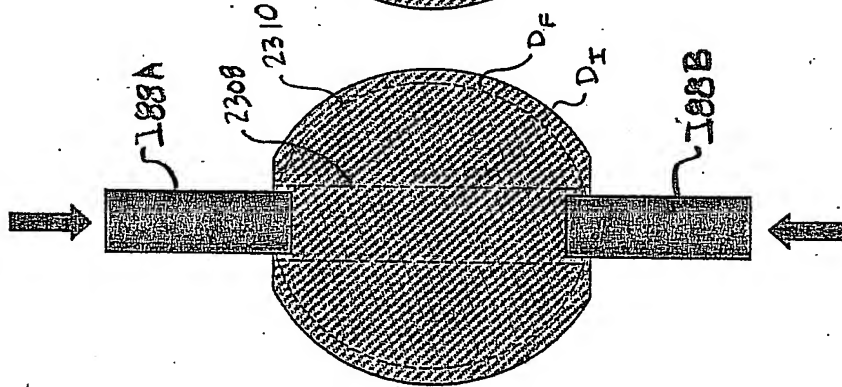


FIG. 90

Drill Hole

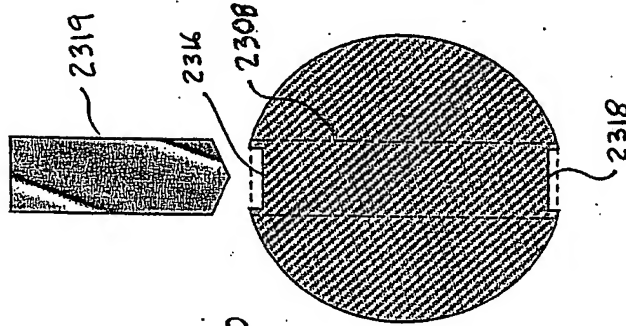


FIG. 91

Final Configurations

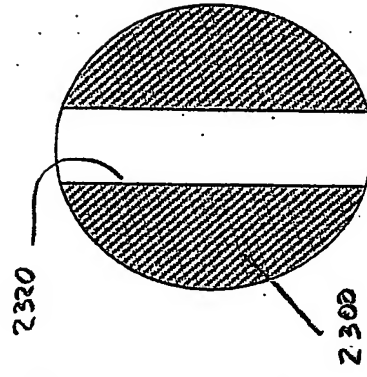
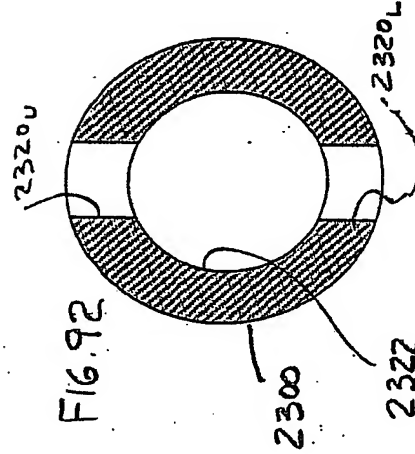


FIG. 92



Treatment of an initially oversized solid bar with opposing "flats" to facilitate treatment

200EFO" 8049900F

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FIG. 93

Setup step

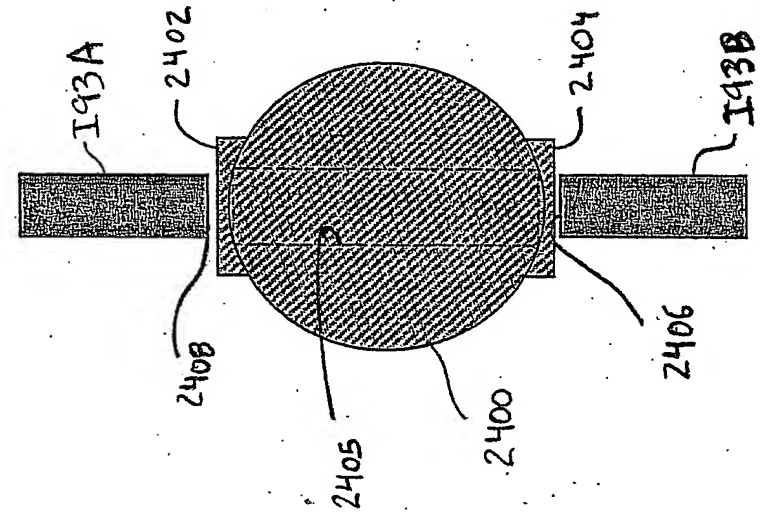


FIG. 94

Processing

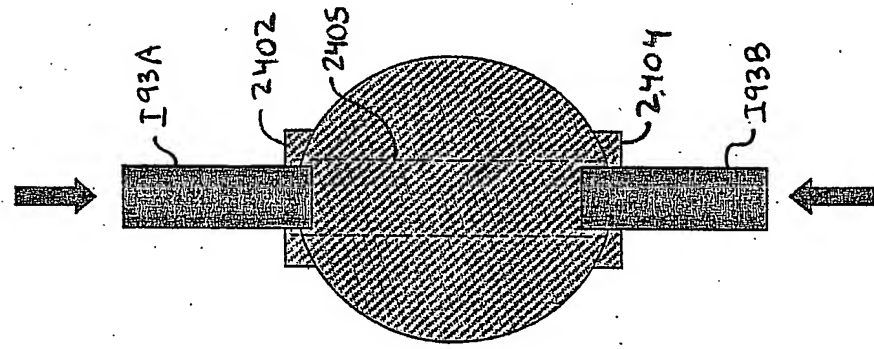


FIG. 95

Drill Hole

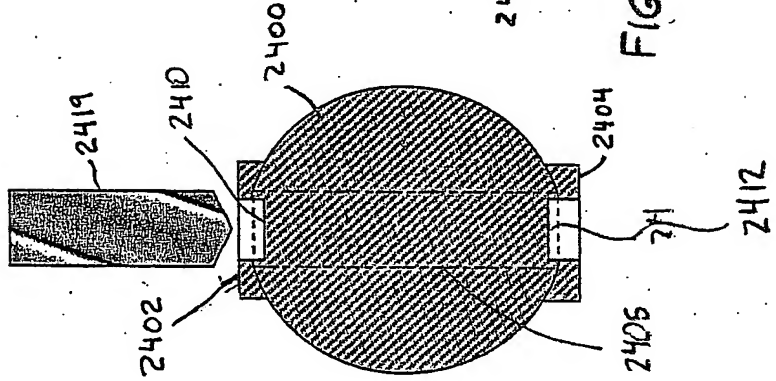


FIG. 96

Final Configurations

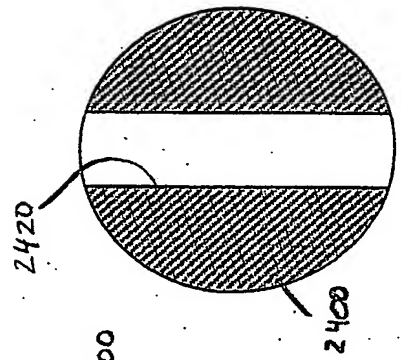
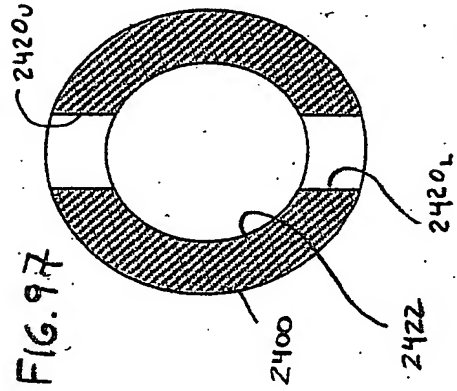


FIG. 97



Treatment of a solid bar with milled or integral
"flats" to facilitate the process

FIG. 98

Process setup step

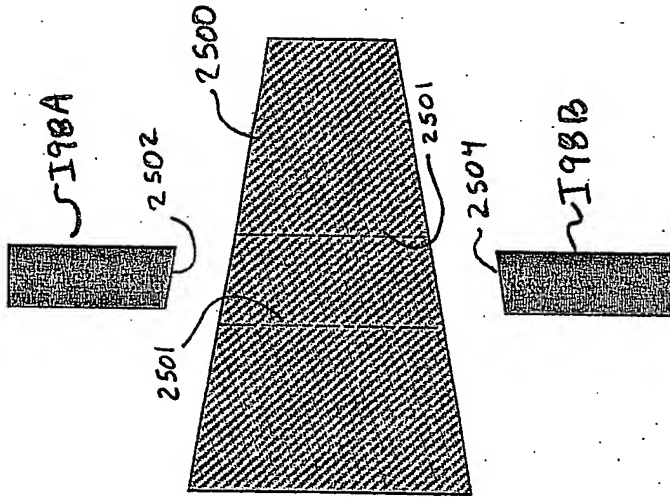
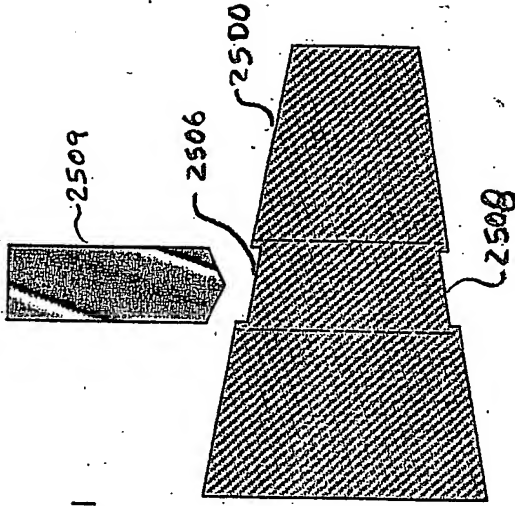


FIG. 99

Drill



Final configuration

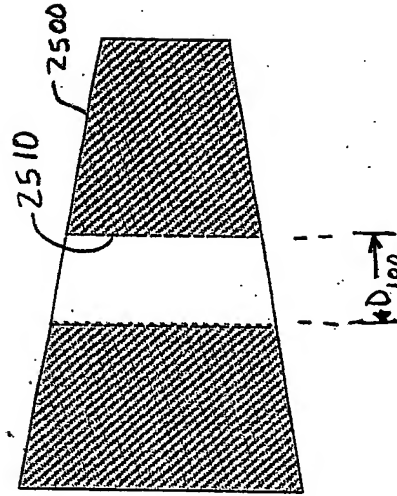


FIG. 100

Treatment of a structure with two tapered surfaces

20049900T

FIG. 101

Process setup step

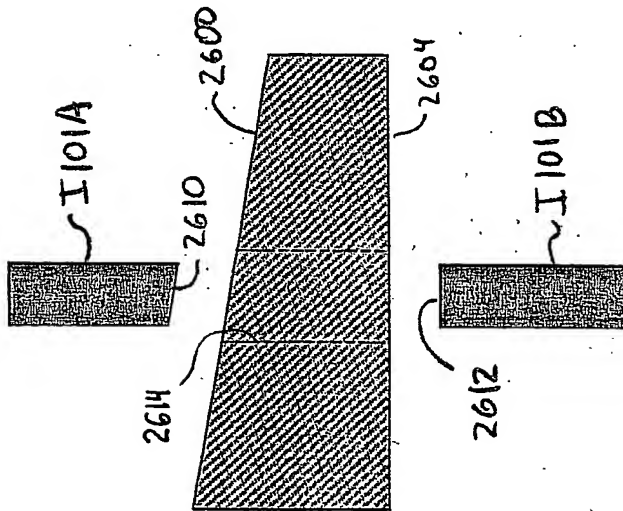


FIG. 101A

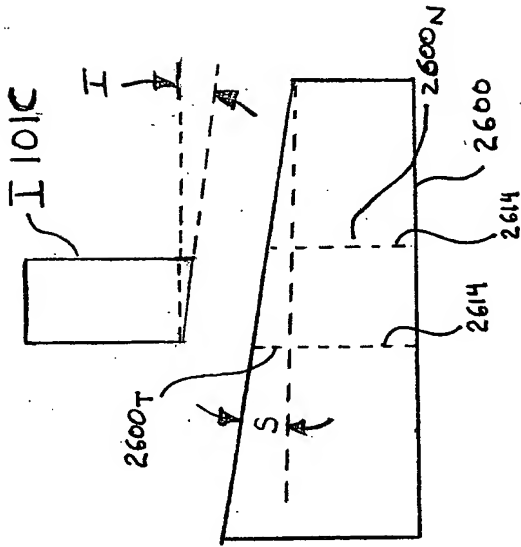
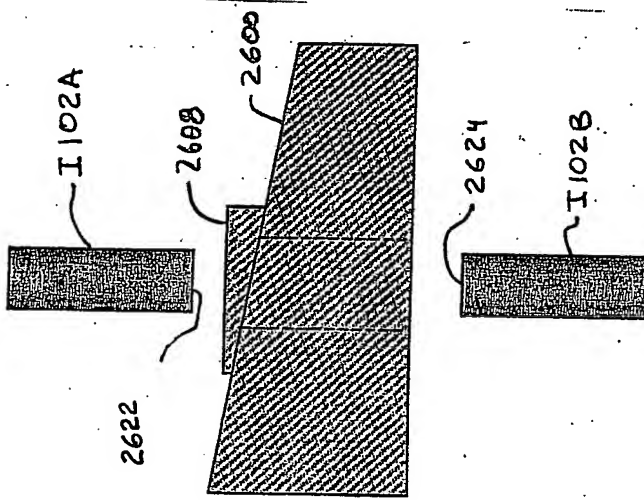


FIG. 102



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Final configuration

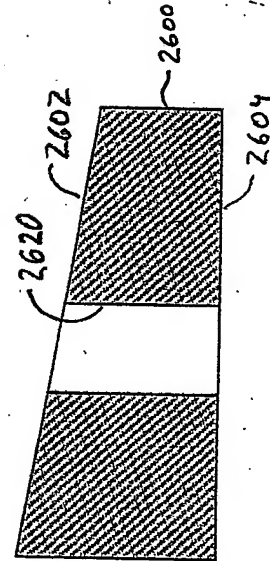


FIG. 103

FIG. 104

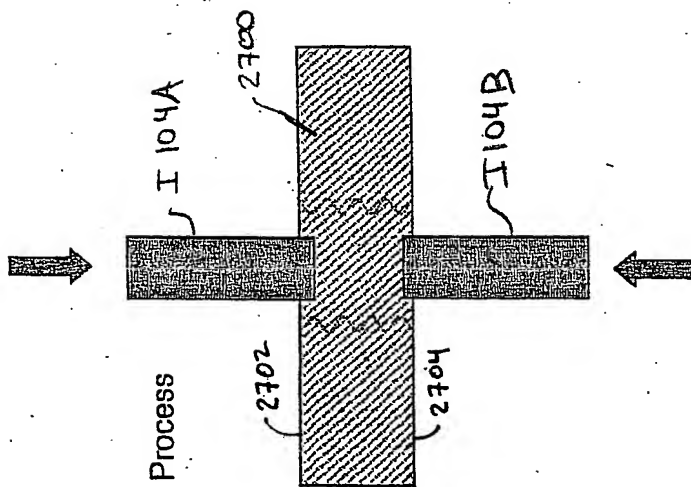


FIG. 105

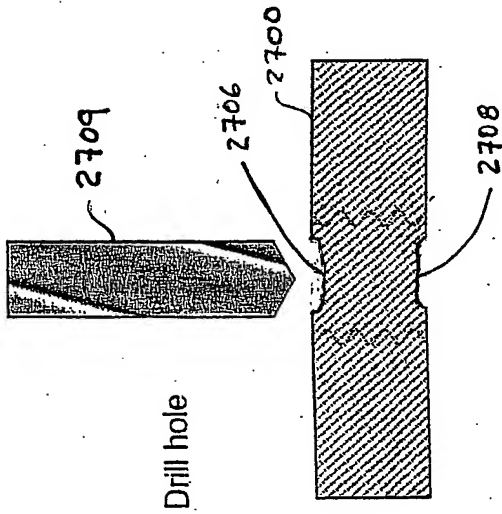
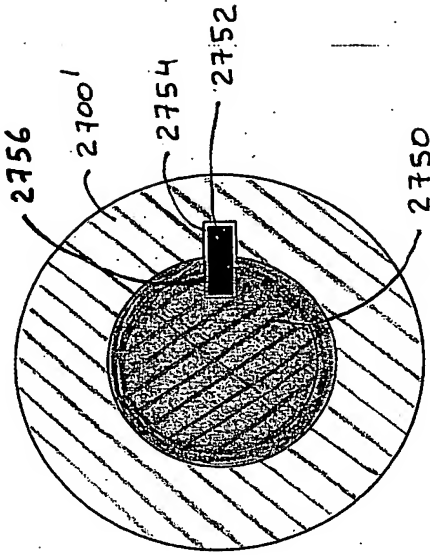


FIG. 106A



Assembled Connection

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FIG. 106B

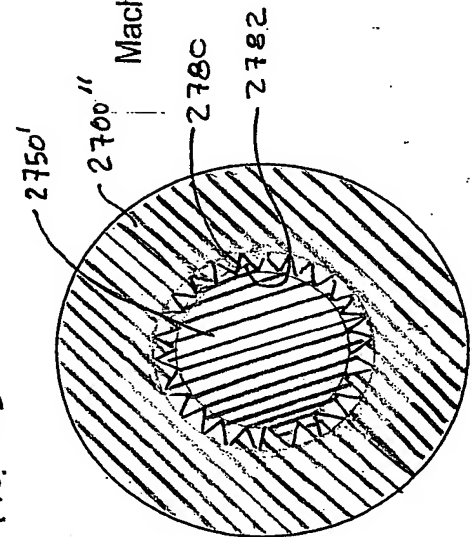


FIG. 106

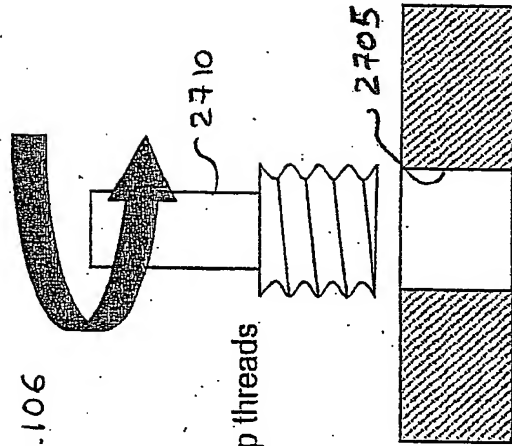
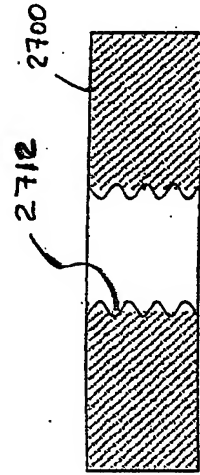
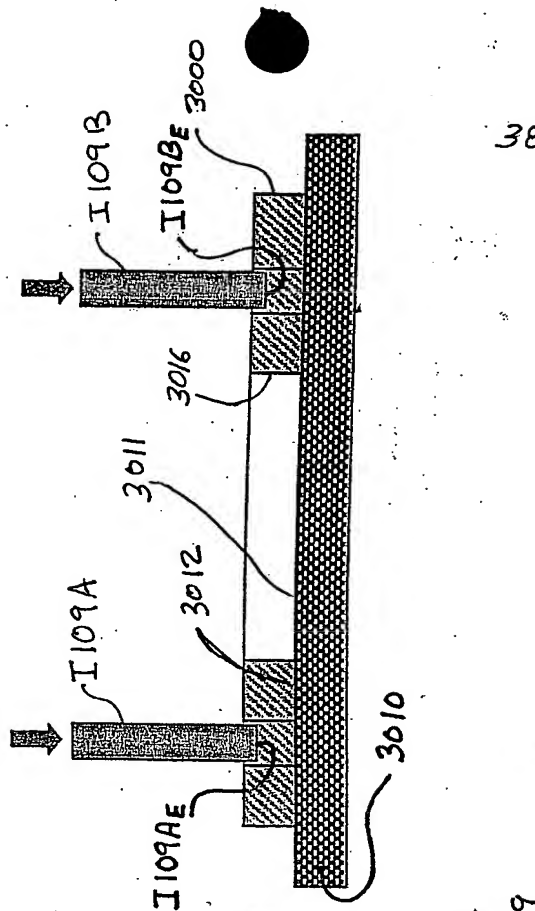
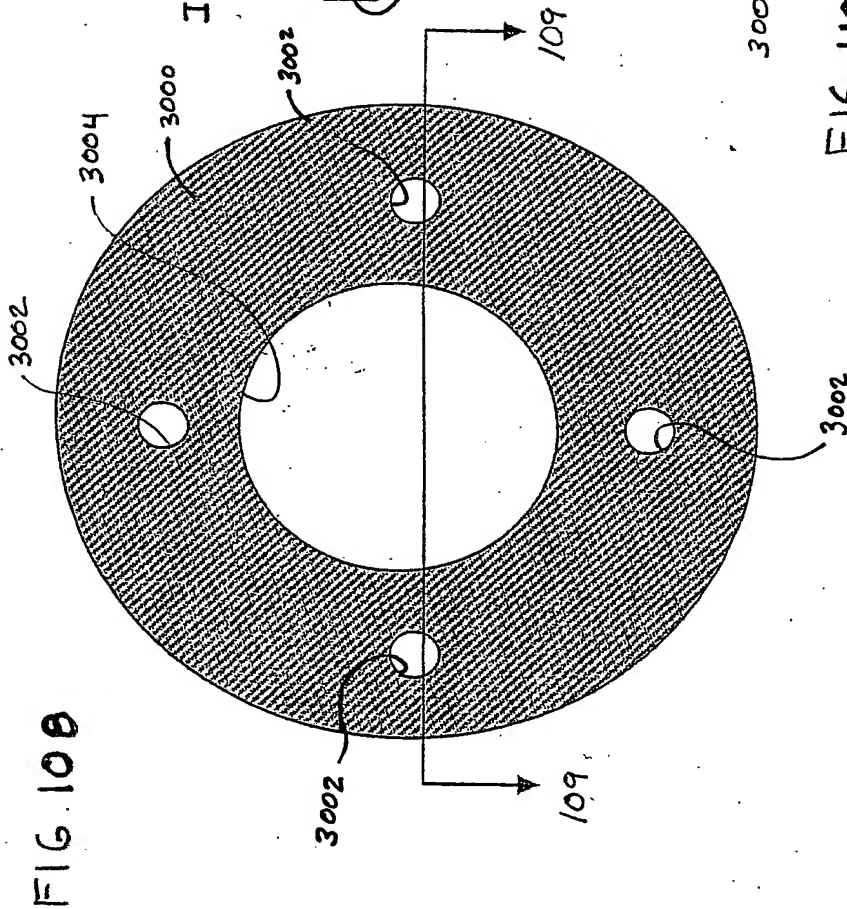


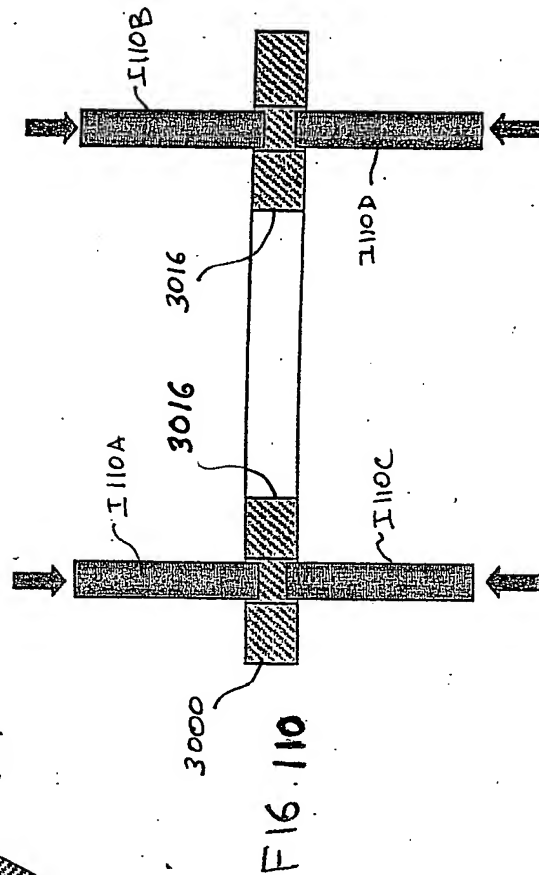
FIG. 107

Finished hole





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Simultaneous or sequential treatment of a pattern
of holes, one-sided or two-sided

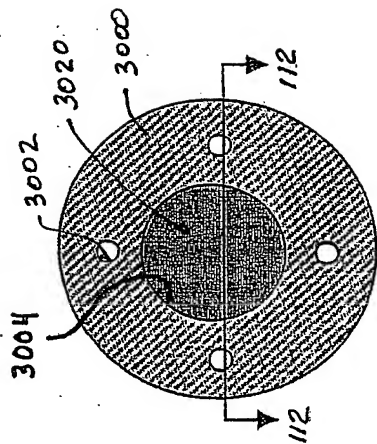


FIG. 111

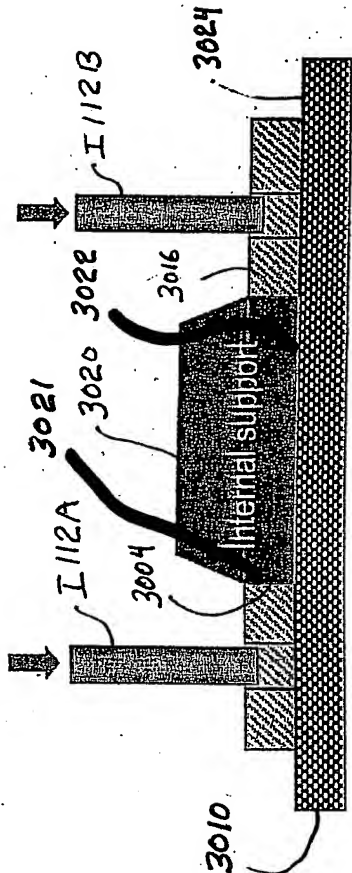


FIG. 112

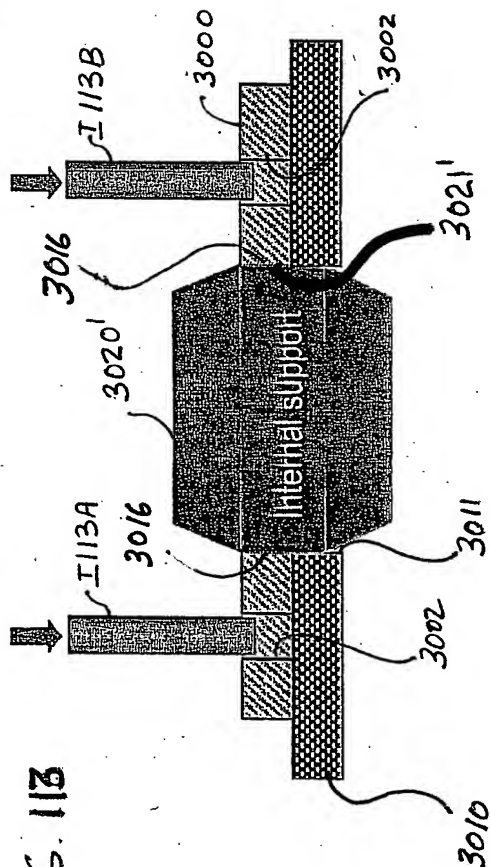


FIG. 113

Support

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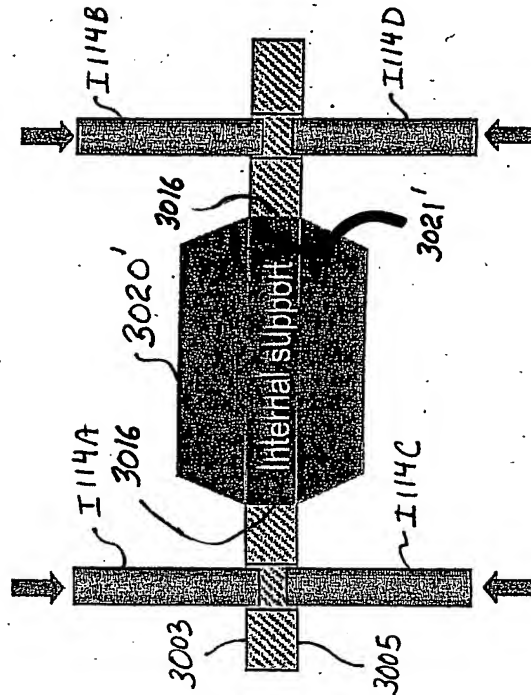


FIG. 114

Simultaneous or sequential treatment of a pattern
 of holes, one-sided or two-sided with internal support

FIG. 118

Machine large hole diameter

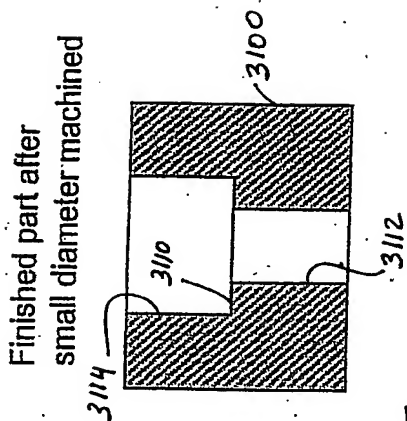


FIG. 115

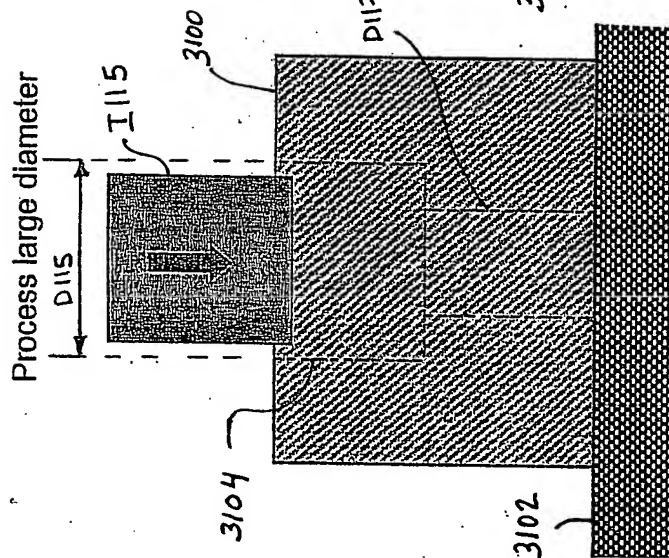
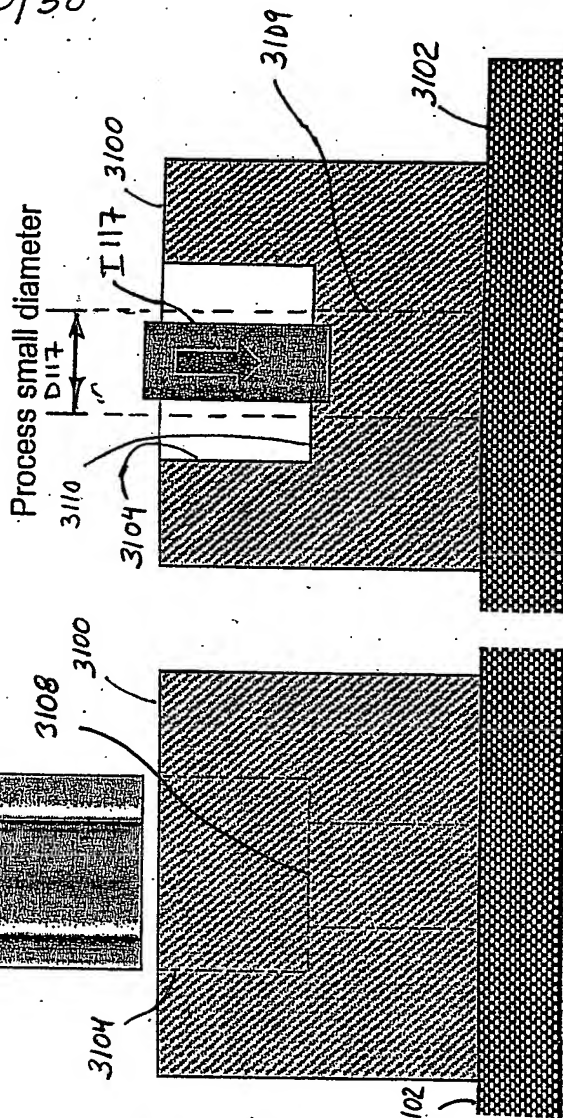


FIG. 117



Treatment of a stepped hole

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FIG. 122

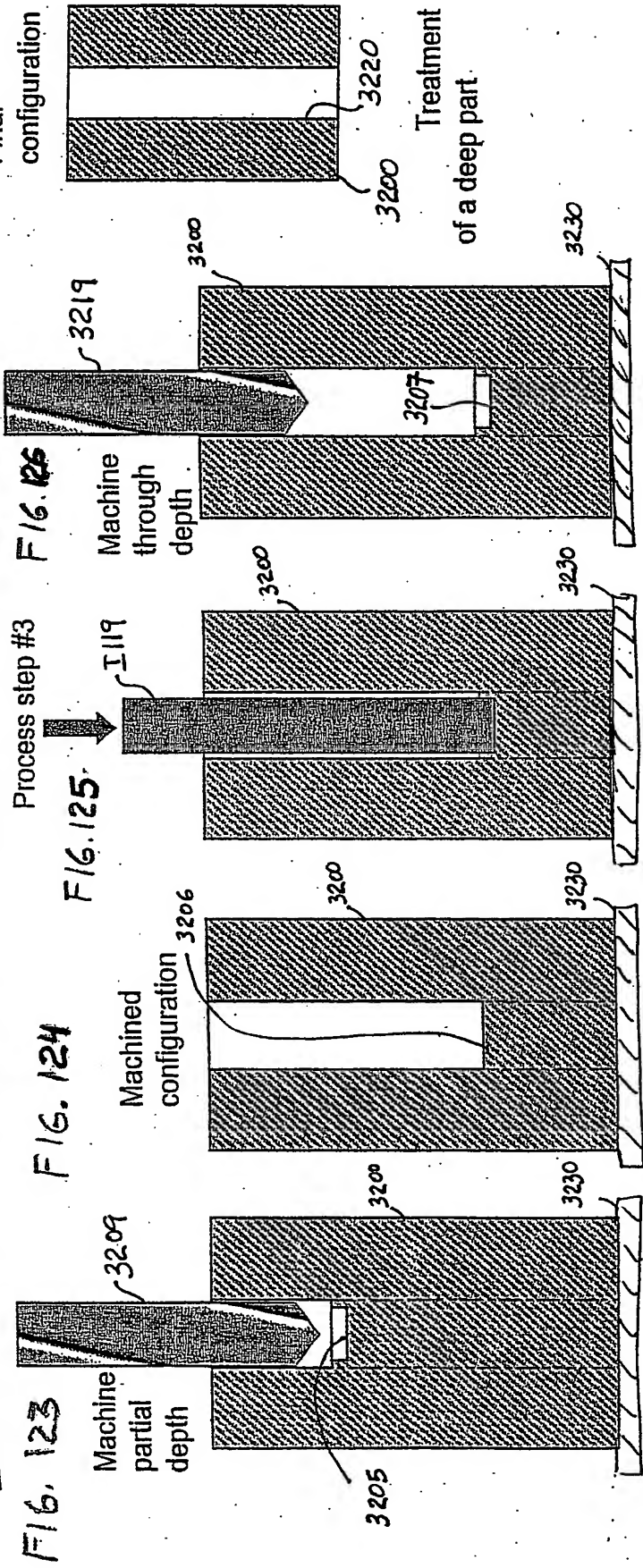
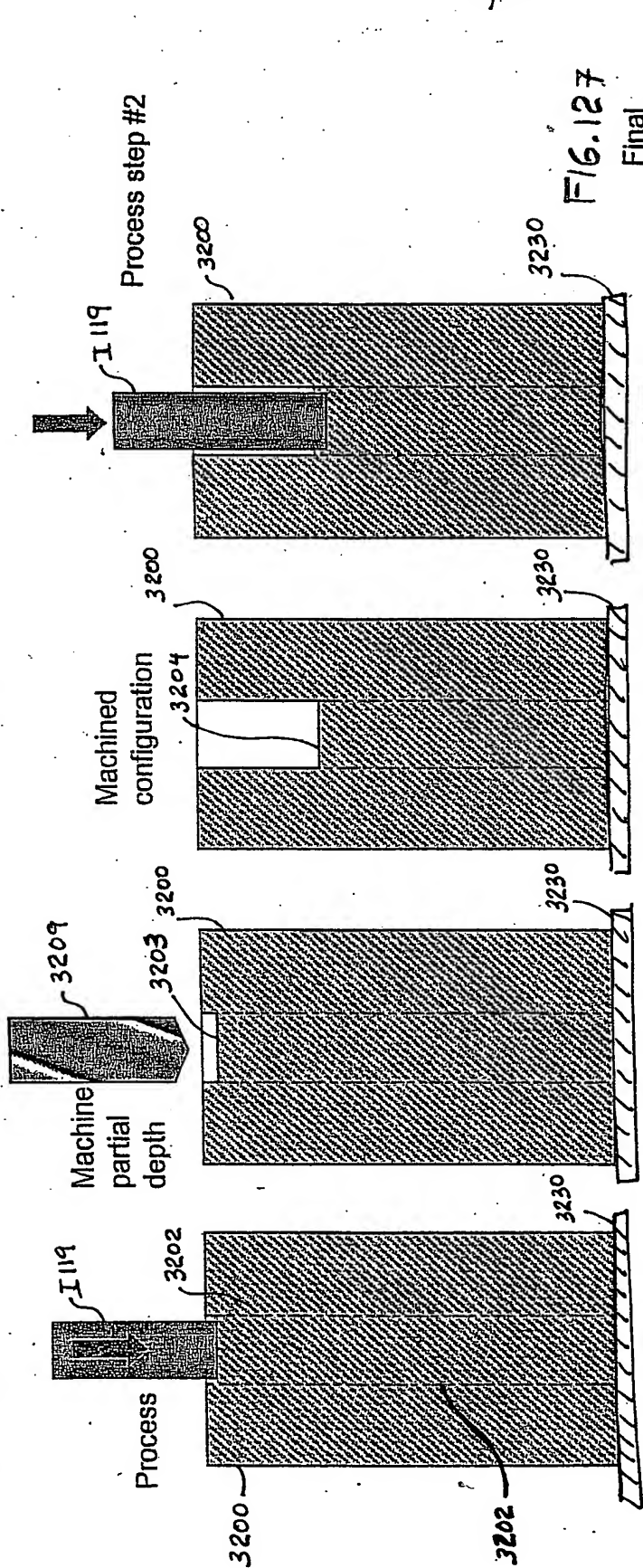
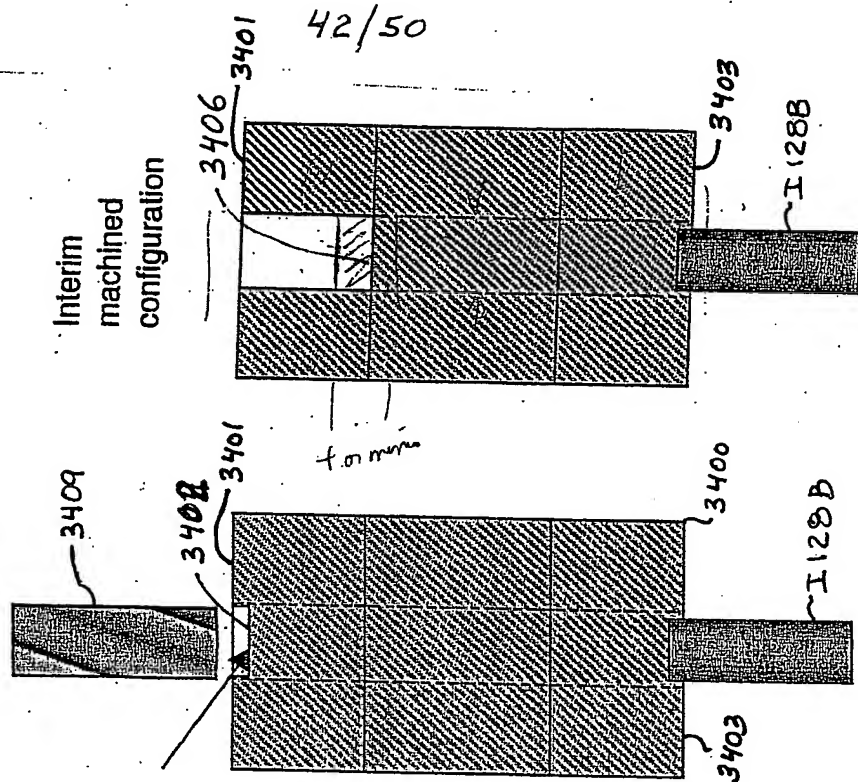
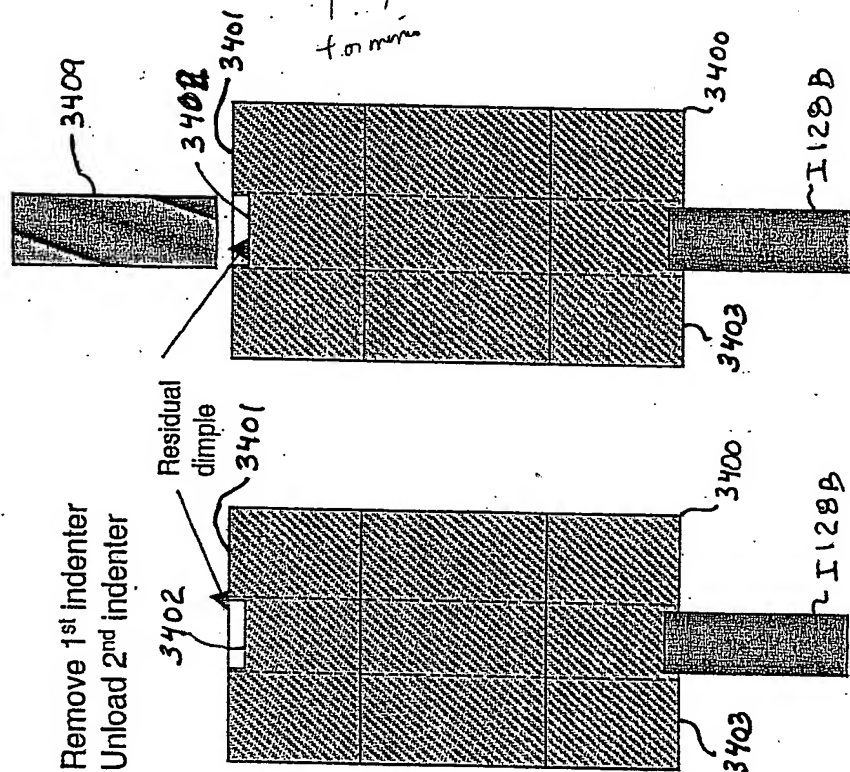
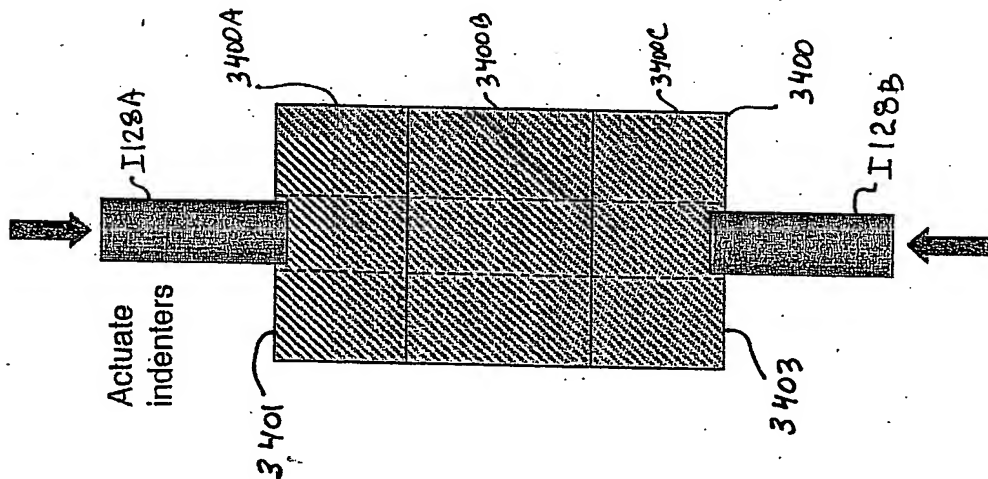


FIG. 120

FIG. 129

FIG. 131



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FIG. 132

Process step #2
 Actuate indenters

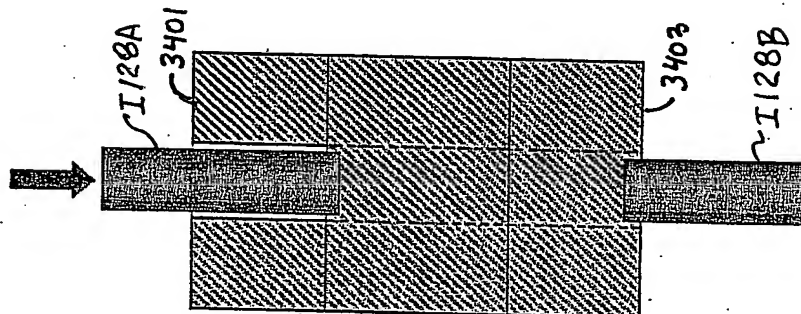


FIG. 133

Release and remove
 indenters

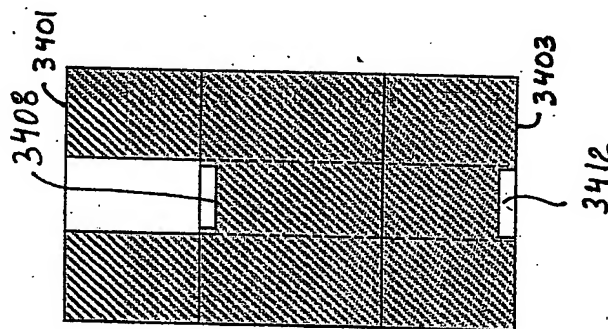


FIG. 134

Final machine
 hole

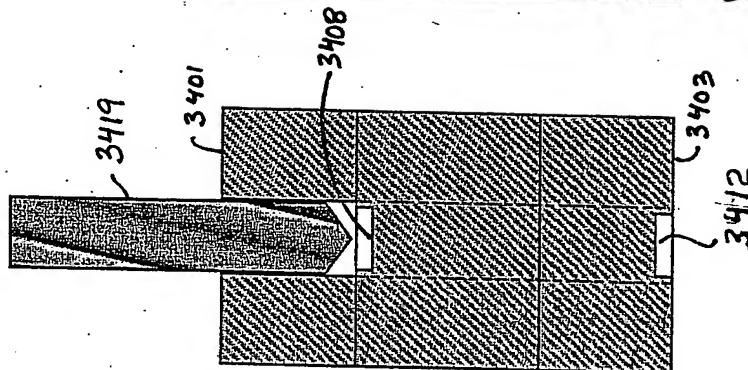
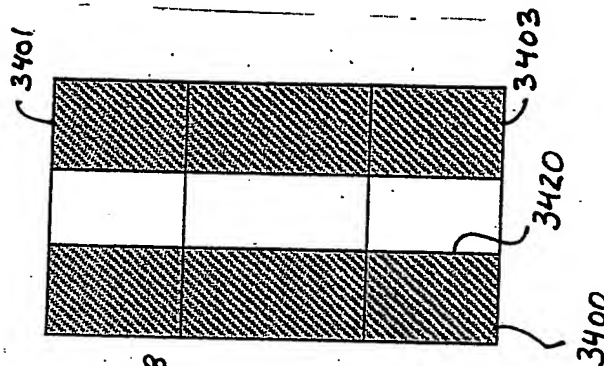


FIG. 135

Final configuration
 Note: hole may have
 countersink, counter-
 bore, step, or other
 feature.



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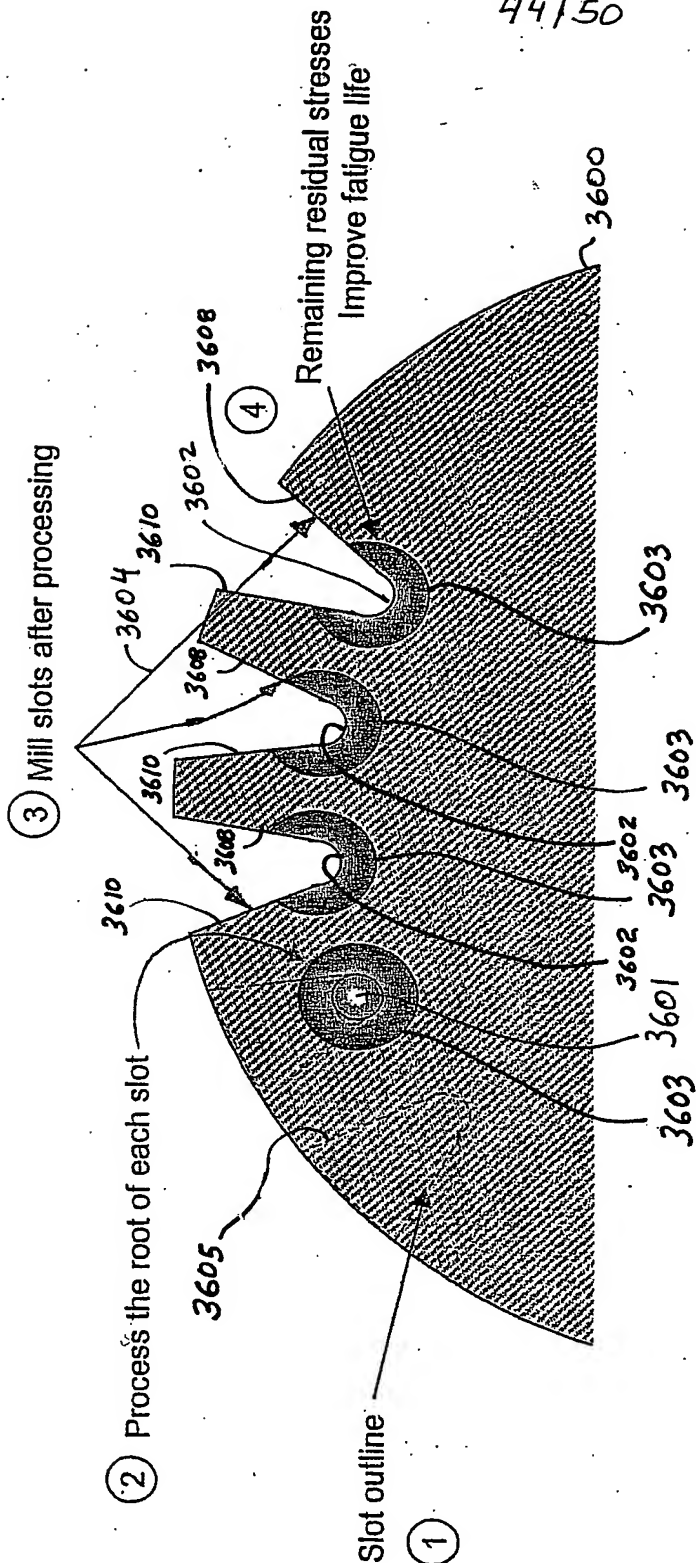
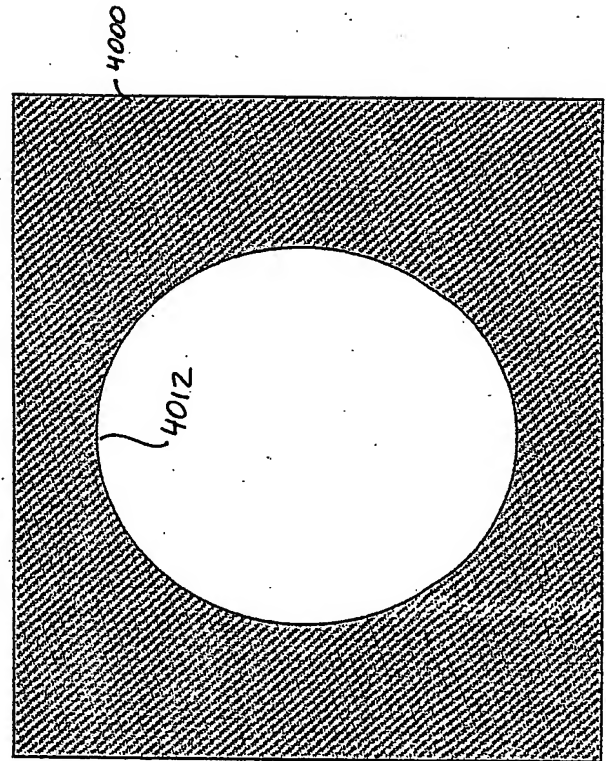
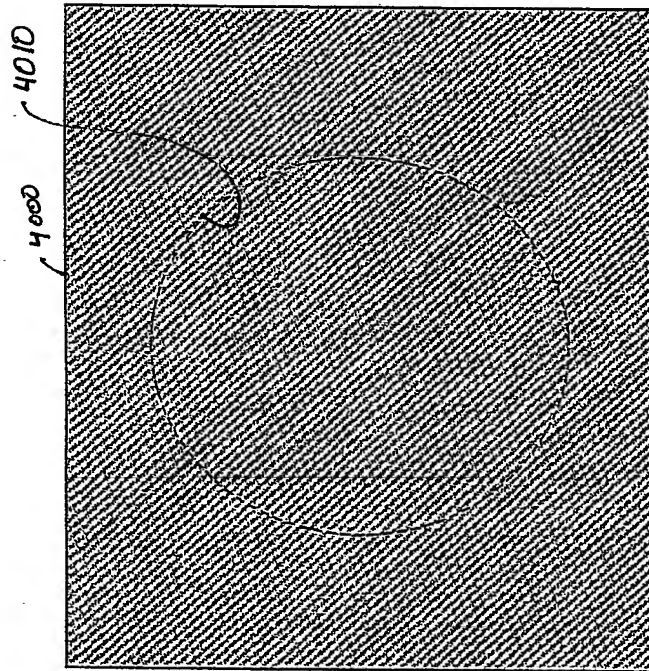
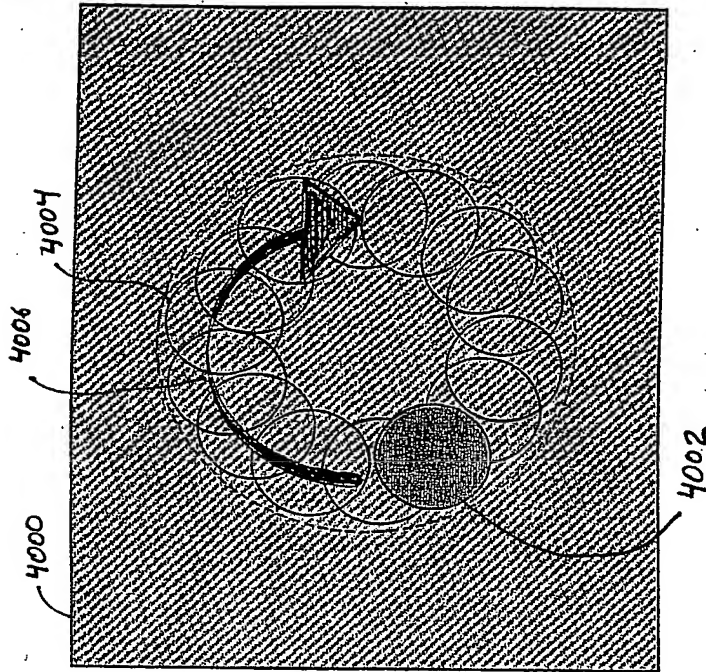


FIG. 136

Treatment of a slotted structure such as a gear or disk



Treatment of a
round aperture using an
overlapping pattern of
dimples around the perimeter

FIG. 138

FIG. 139

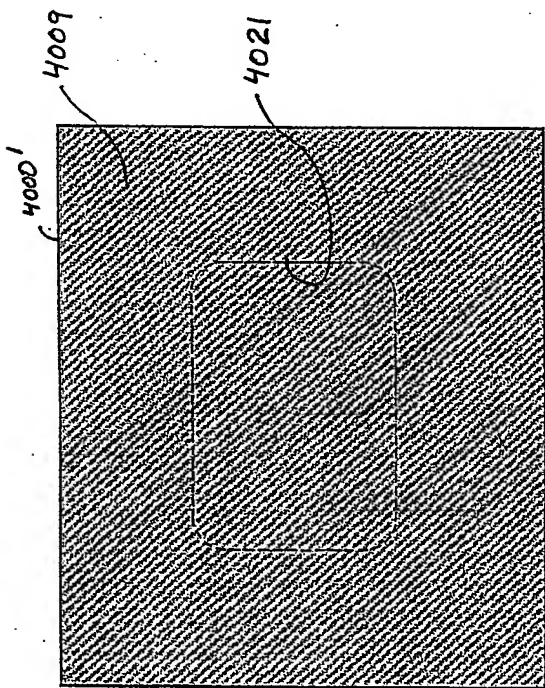


FIG. 140

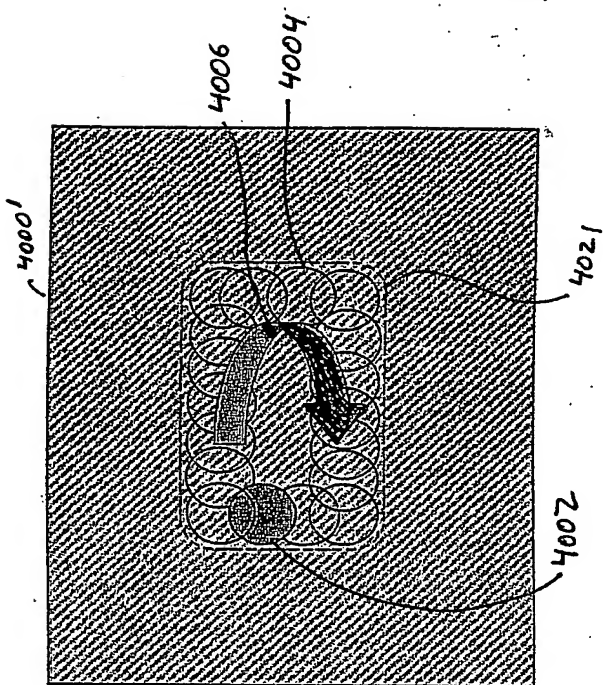


FIG. 141

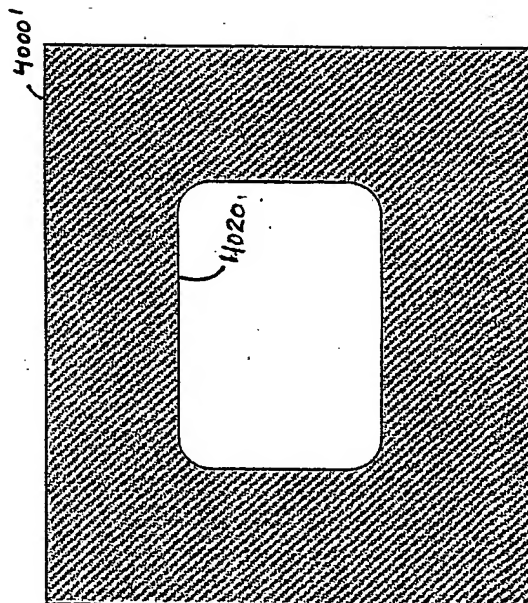
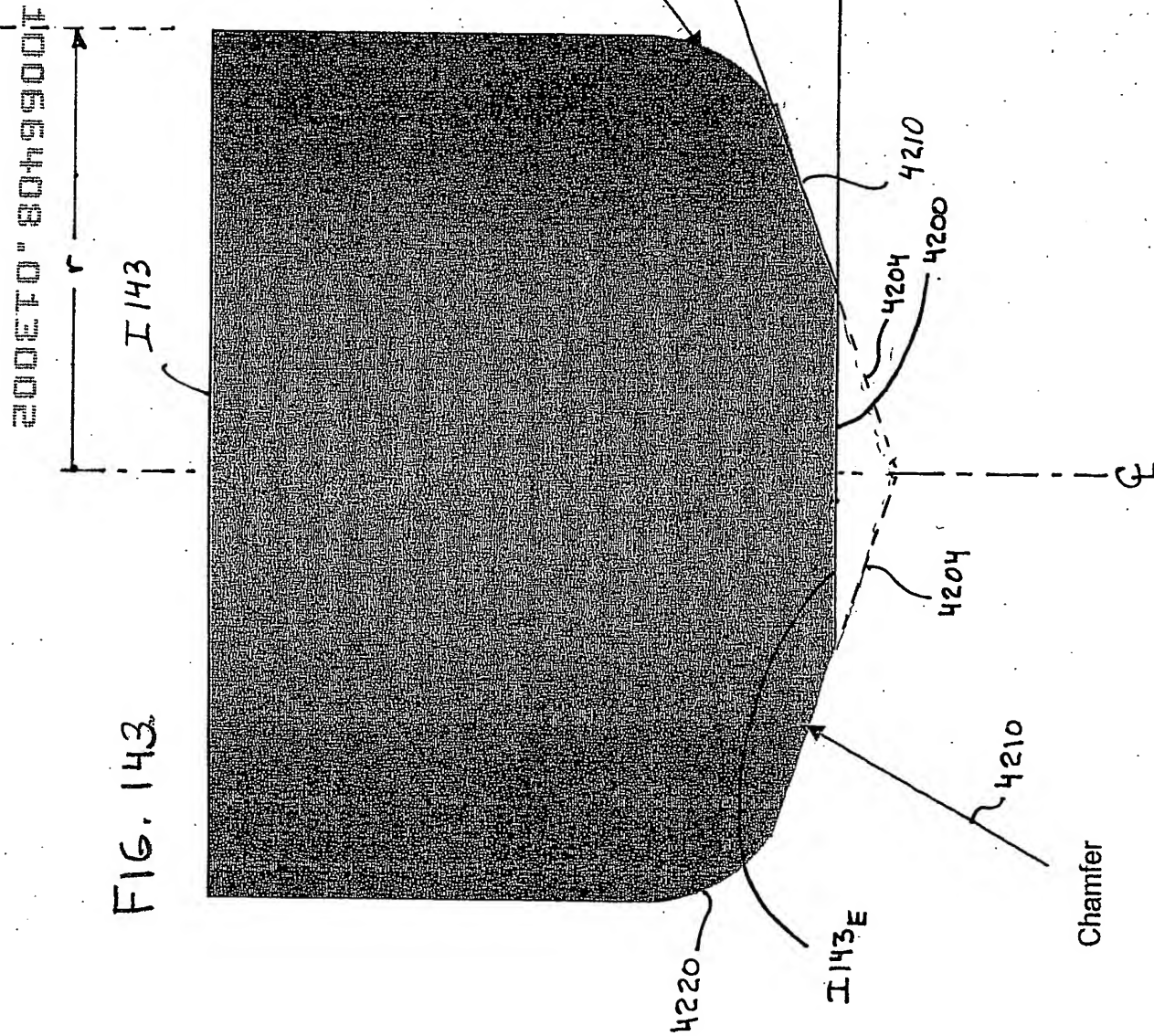


FIG. 142

Treatment of a
non-circular aperture using
an overlapping pattern of
dimples around the perimeter

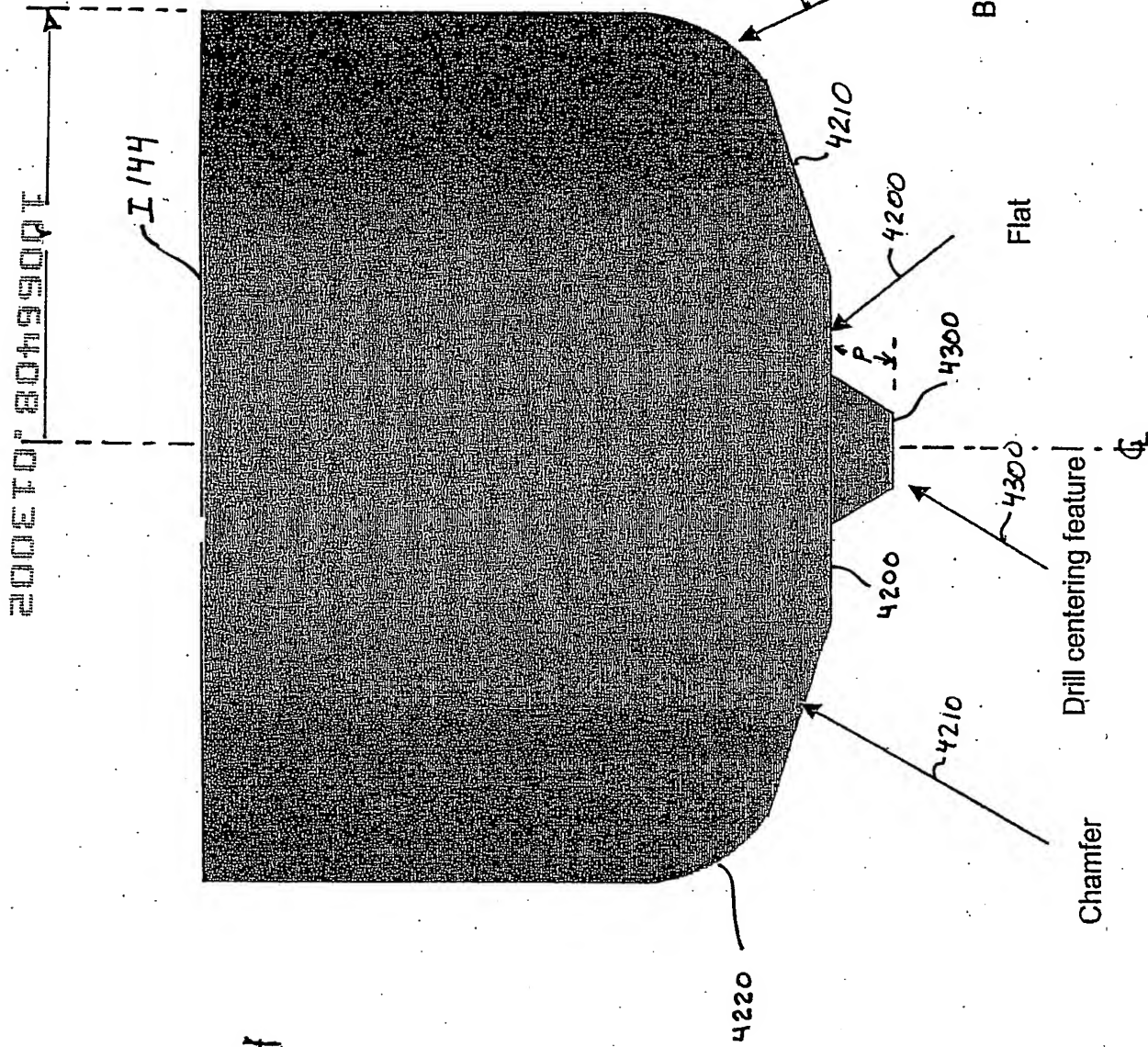
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FIG. 143



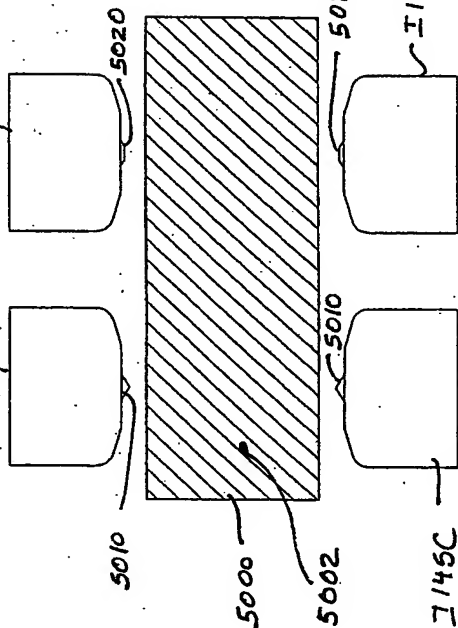
Indenter end shape using flat, chamfered and curved portions for approximating a uniform pressure profile

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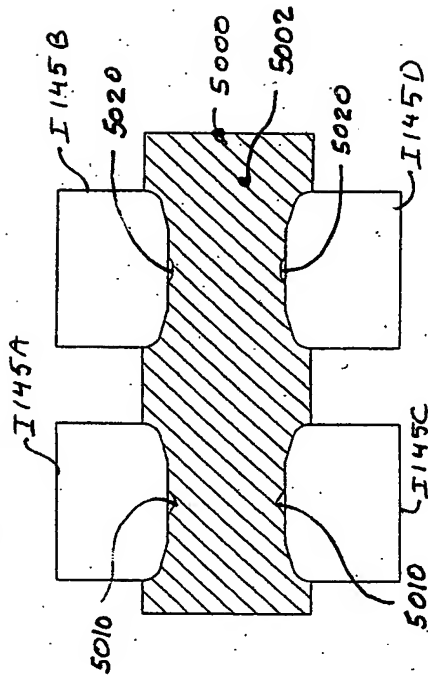
Indenter end shape for approximating a uniform
 pressure profile with drill center feature

FIG. 145



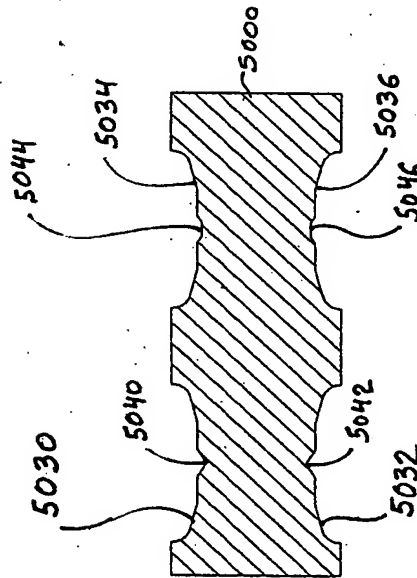
Setup Step for Two Indenter End Styles
With Drill Aligning Feature. One Conical and the
Other a Truncated Cone

FIG. 146



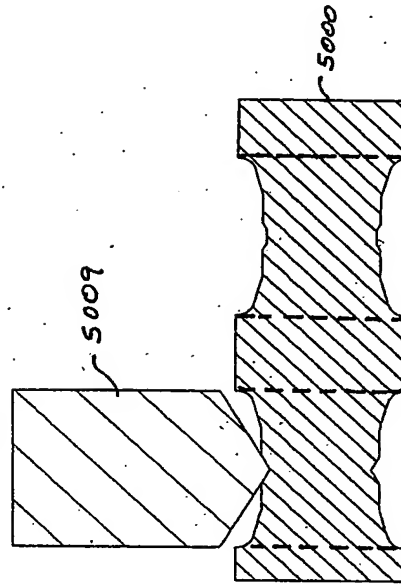
Actuation of Indenters Into Part

FIG. 147



Cross Section of Dimples After
Treatment and Indenter Withdrawal

FIG. 148

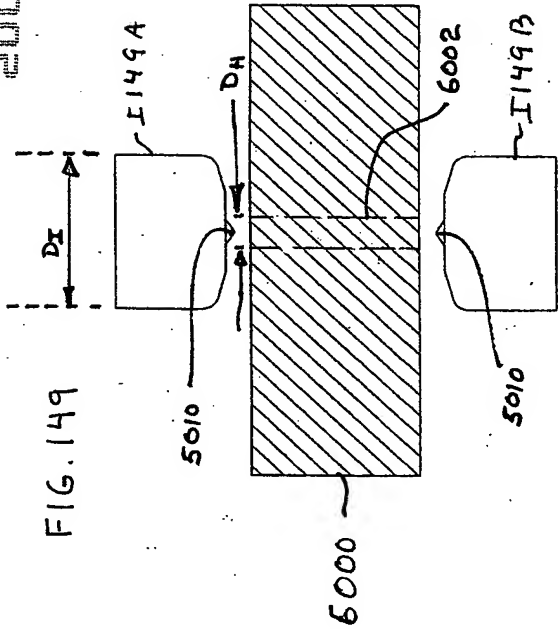


Drill Out Hole, Drill Centers on Dimple

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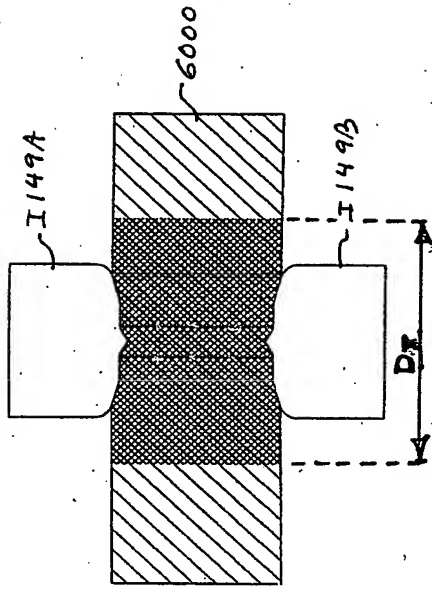
200270-80499001

FIG. 149



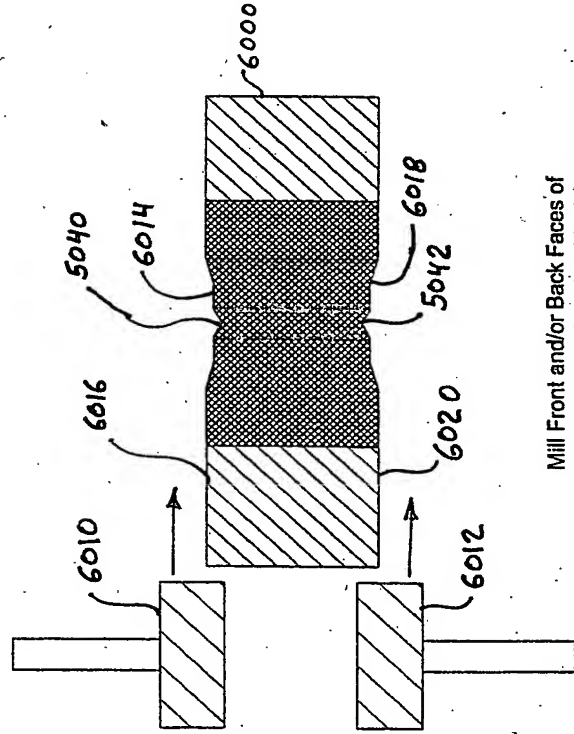
Setup Step for Treating Part With Extra Thickness Using Indenters Much Larger Than the Final Hole Diameter

FIG. 150



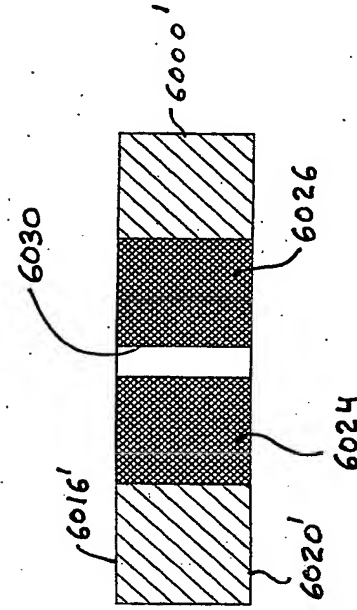
Actuation of Indenters Into Part, Extent of Residual Stress Well Beyond the Future Wall of the Small Diameter Hole

FIG. 151



Mill Front and/or Back Faces of Structure to Remove Dimples - Residual Stresses May Relax Slightly

FIG. 152



Drill Out Hole Leaving Large Zone of Compressive Residual Stress